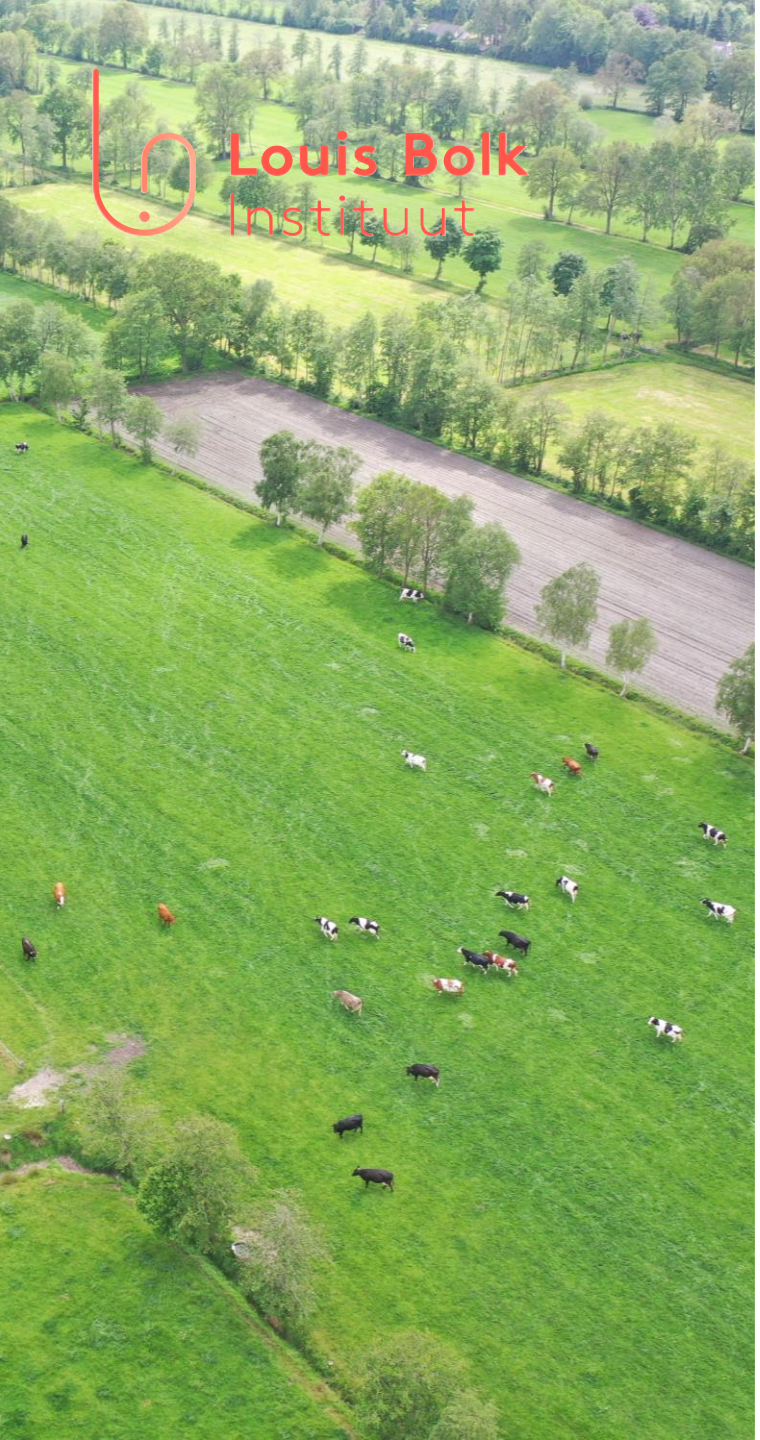

The past and future of nitrogen use efficiency in agriculture

Jan Willem Erisman

VU UNIVERSITY AMSTERDAM
LOOKING FURTHER

Gent, 27 August 2019

70TH ANNUAL MEETING OF THE EUROPEAN FEDERATION OF ANIMAL SCIENCE
ANIMAL FARMING FOR A HEALTHY WORLD
EAAP 2019
GHENT – BELGIUM
26 – 30 AUGUST 2019

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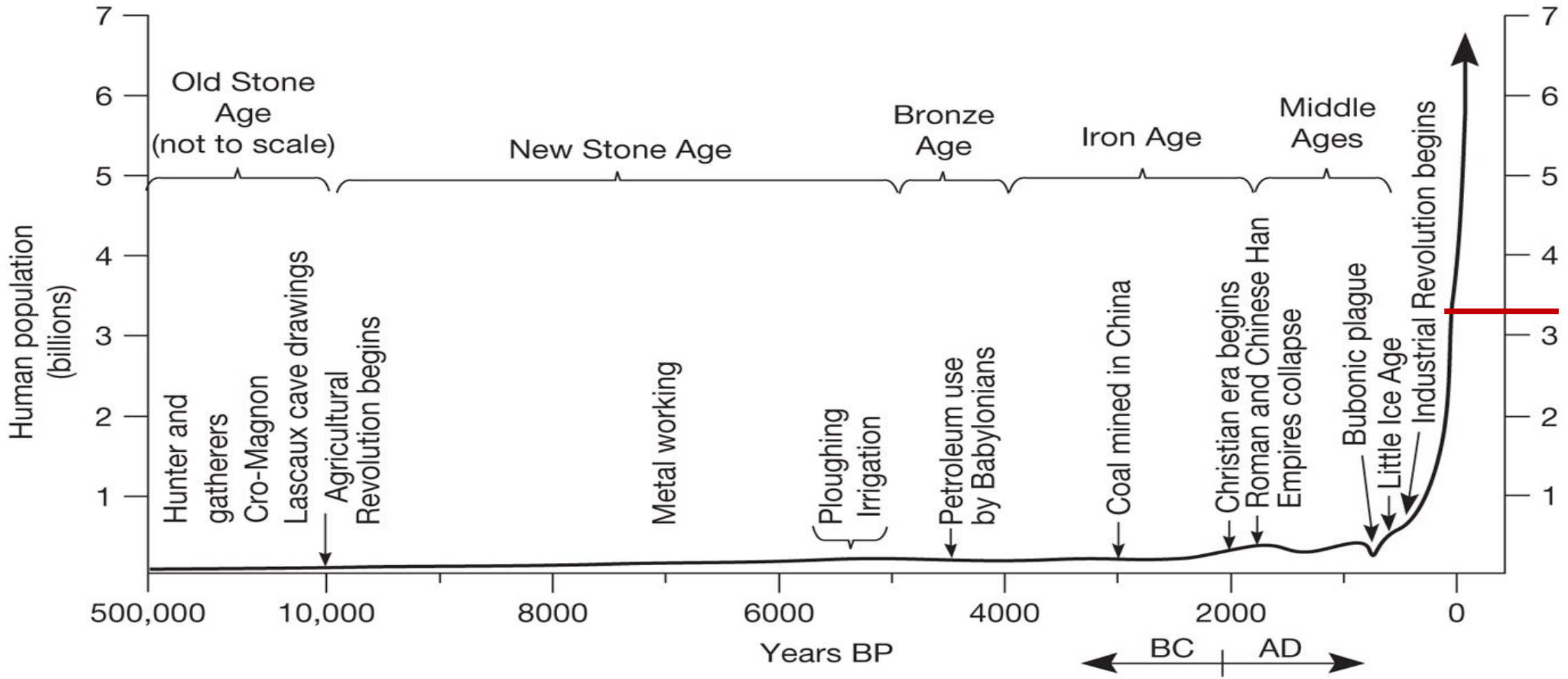
From no N problem to different N problems

Essential ---------- enough ---------- too little - too much



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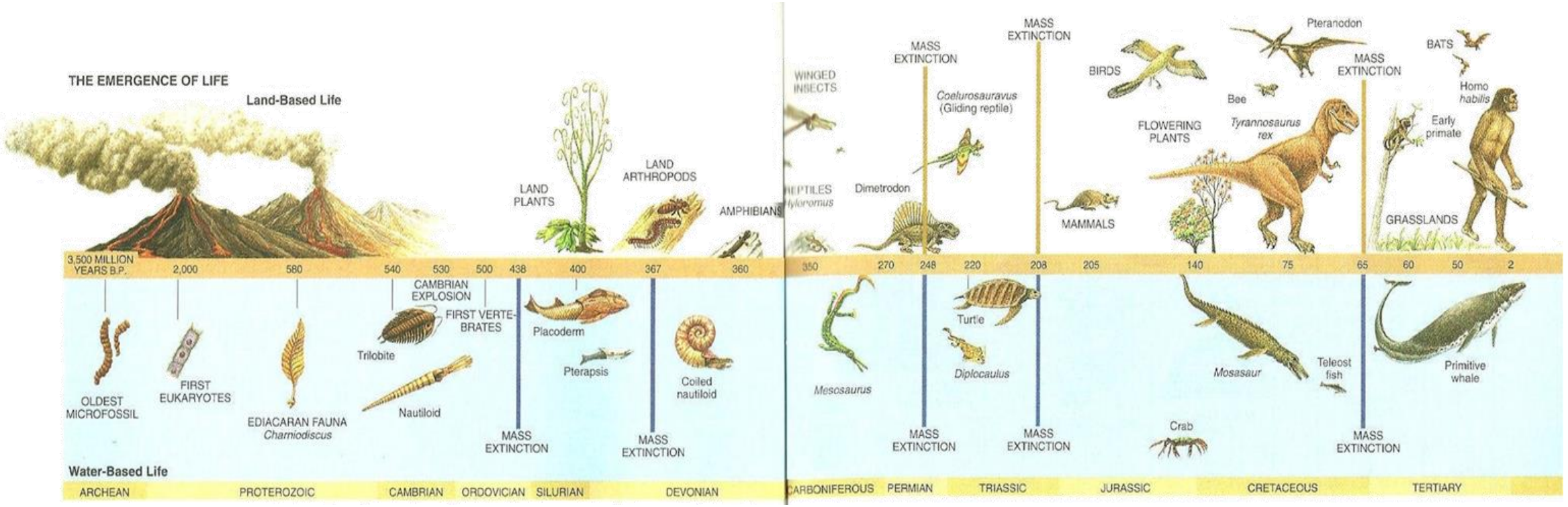
Origin of life: nitrogen played a key role

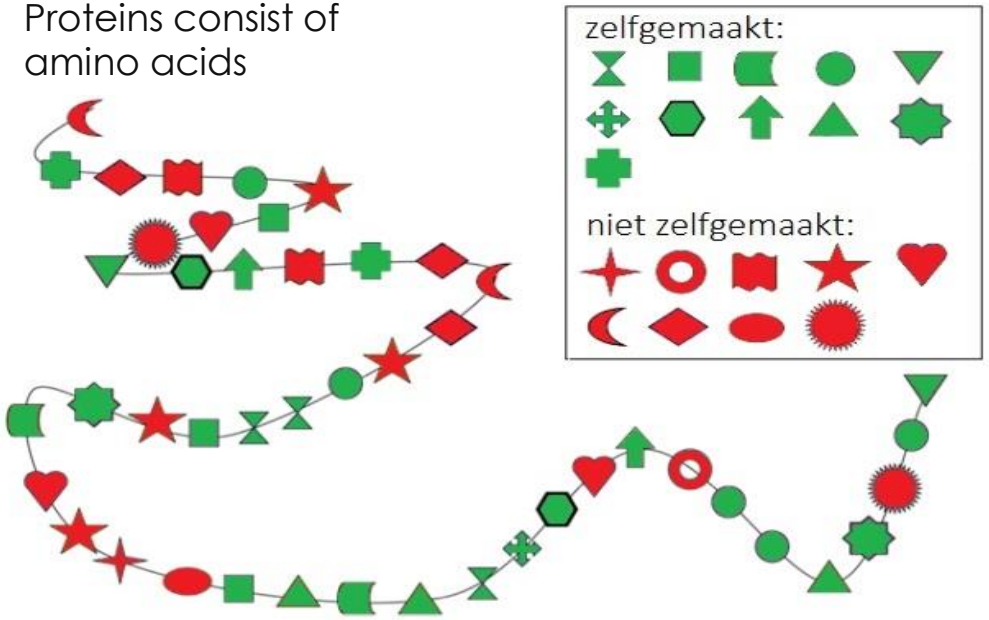


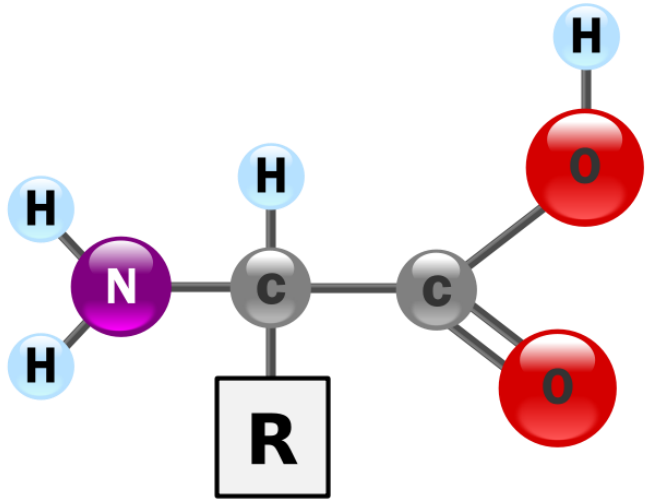
N helped fix Carbon to organic matter in oceans leading to bacteria formation
N can accept and discharge electrons: basis for amino acids

All organisms need food to survive and Nitrogen is an essential component

Insufficient protein in the diet may prevent the body from producing adequate levels of peptide hormones and structural proteins to sustain normal bodily functions

Proteins consist of amino acids





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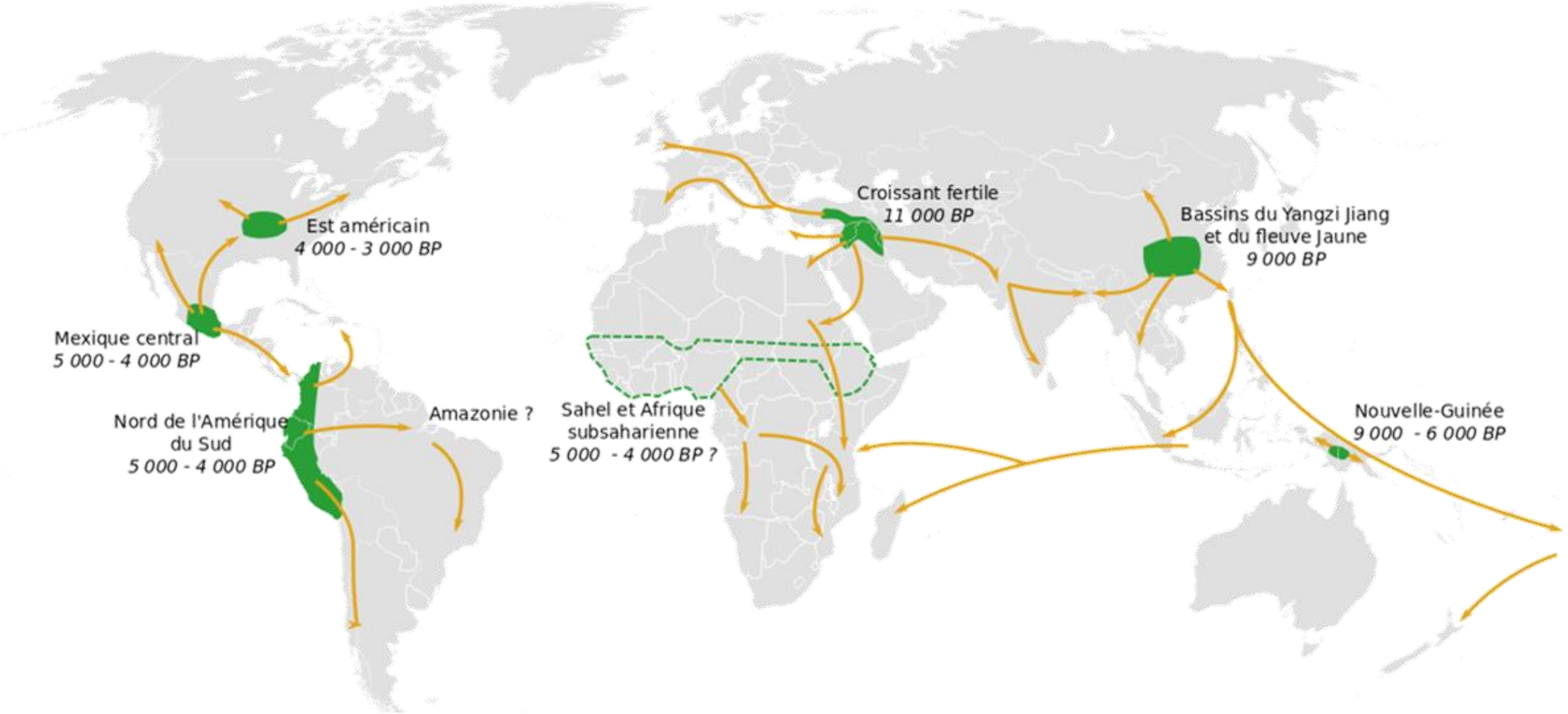
First known settlements 10.000 BC



Agriculture arose where valuable domesticable crops were native, other areas proved more productive when domesticates introduced

Diamond et al. 2003

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Natural sources of reactive nitrogen

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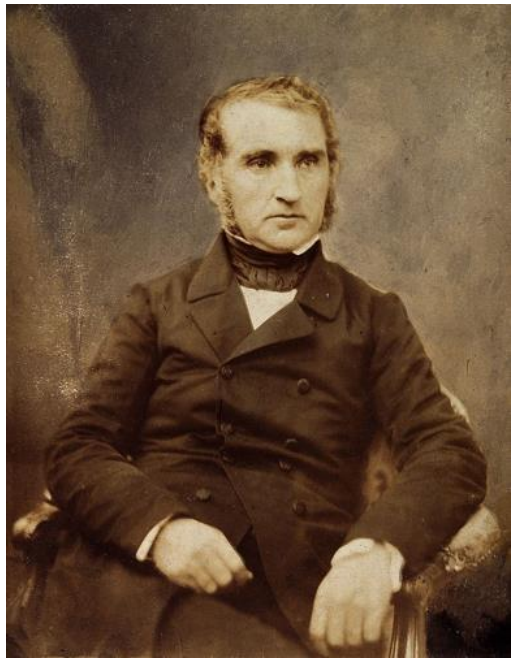
N shortage for gunpowder

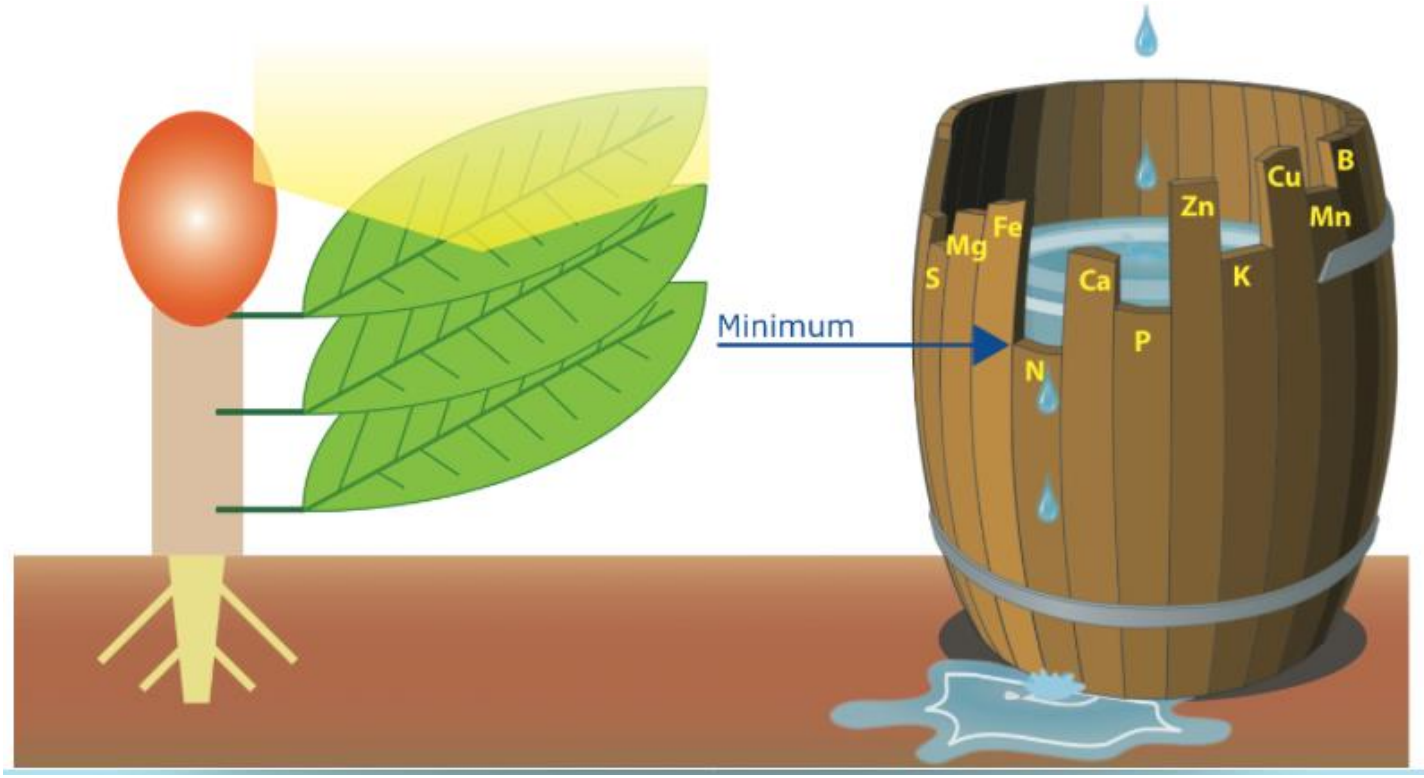
- Roger Bacon (1249) introduced gunpowder
- 1600: Demand for salpetre : Sweden nitre beds – soil, sheep dung, ashed, wood and straw; UK the salpetre collectors, Peterman: worse than tax collectors

Nitrary, 1580

Justus von Liebig: N-limitation in agriculture



Justus von Liebig (1803–1873)



Law of the minimum:
The element which is in shortest supply limtits the yield

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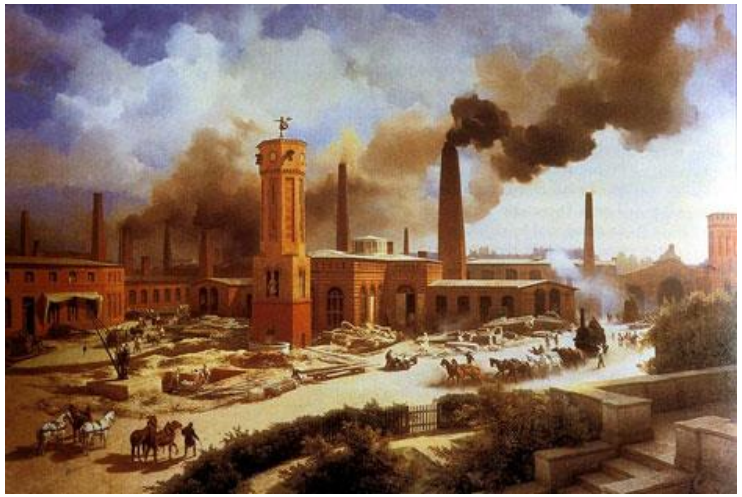
Industrial Revolution: Global pop. 800 million

From: rural areas

Agriculture

system: closed cycles

To: cities



Industrialization

specialization

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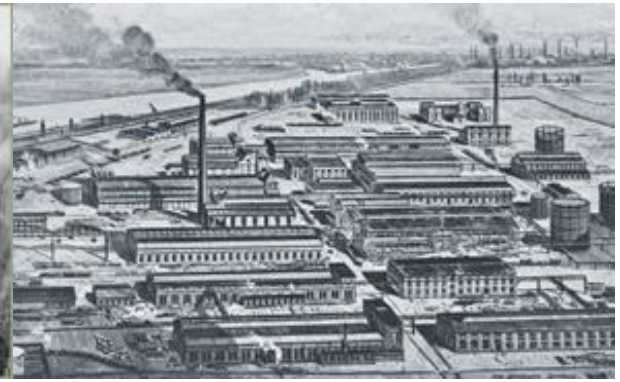
The Haber-Bosch process: 110 years of fertilizers

FEATURE

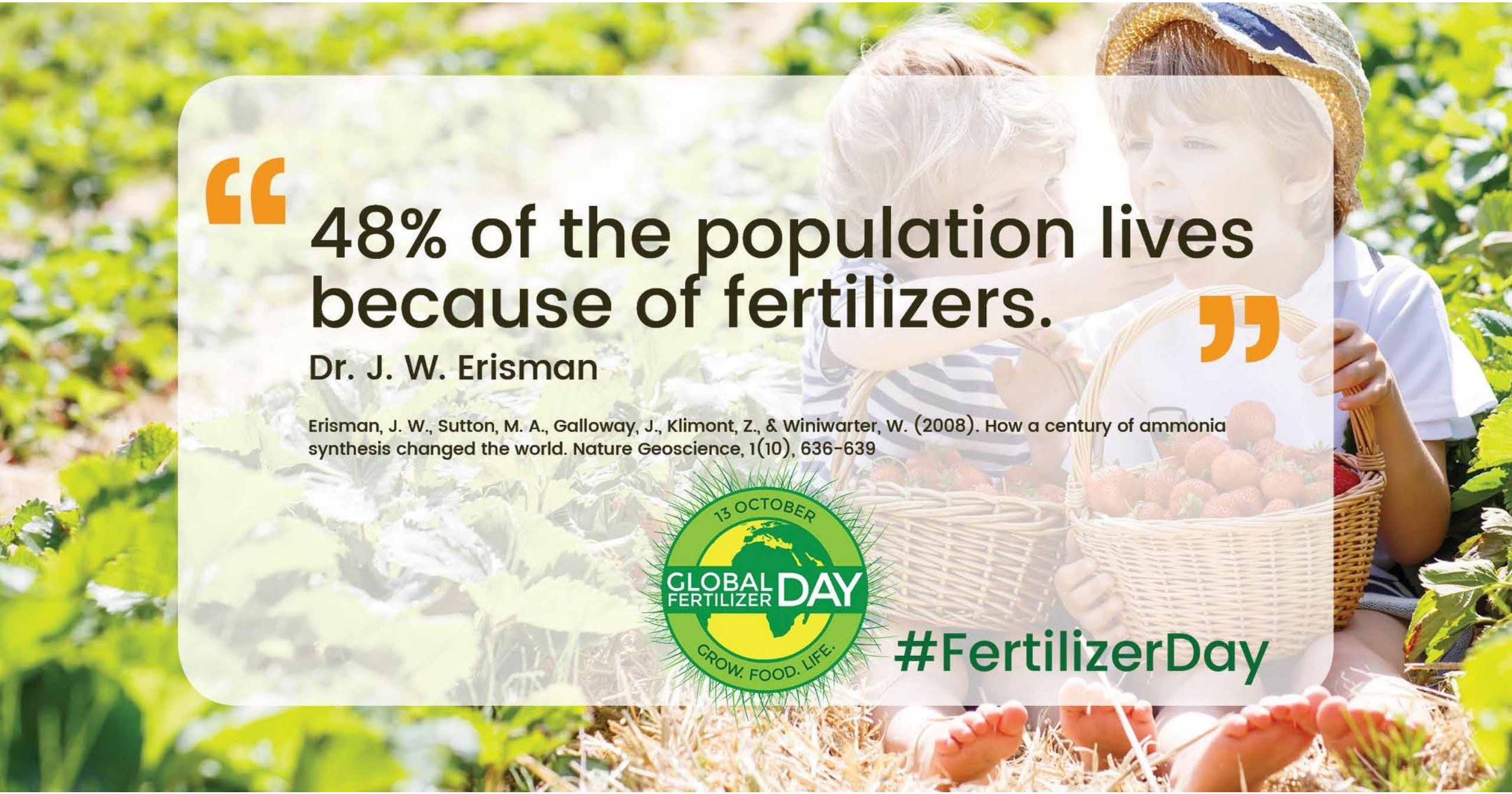
How a century of ammonia synthesis changed the world

On 13 October 1908, Fritz Haber filed his patent on the "synthesis of ammonia from its elements" for which he was later awarded the 1918 Nobel Prize in Chemistry. A hundred years on we live in a world transformed by and highly dependent upon Haber–Bosch nitrogen.



Erisman et al., 2008

www.basf.com


“
48% of the population lives because of fertilizers.
”
Dr. J. W. Erisman
Erisman, J. W., Sutton, M. A., Galloway, J., Klimont, Z., & Winiwarter, W. (2008). How a century of ammonia synthesis changed the world. Nature Geoscience, 1(10), 636-639
13 OCTOBER
GLOBAL FERTILIZER DAY
GROW. FOOD. LIFE.
#FertilizerDay

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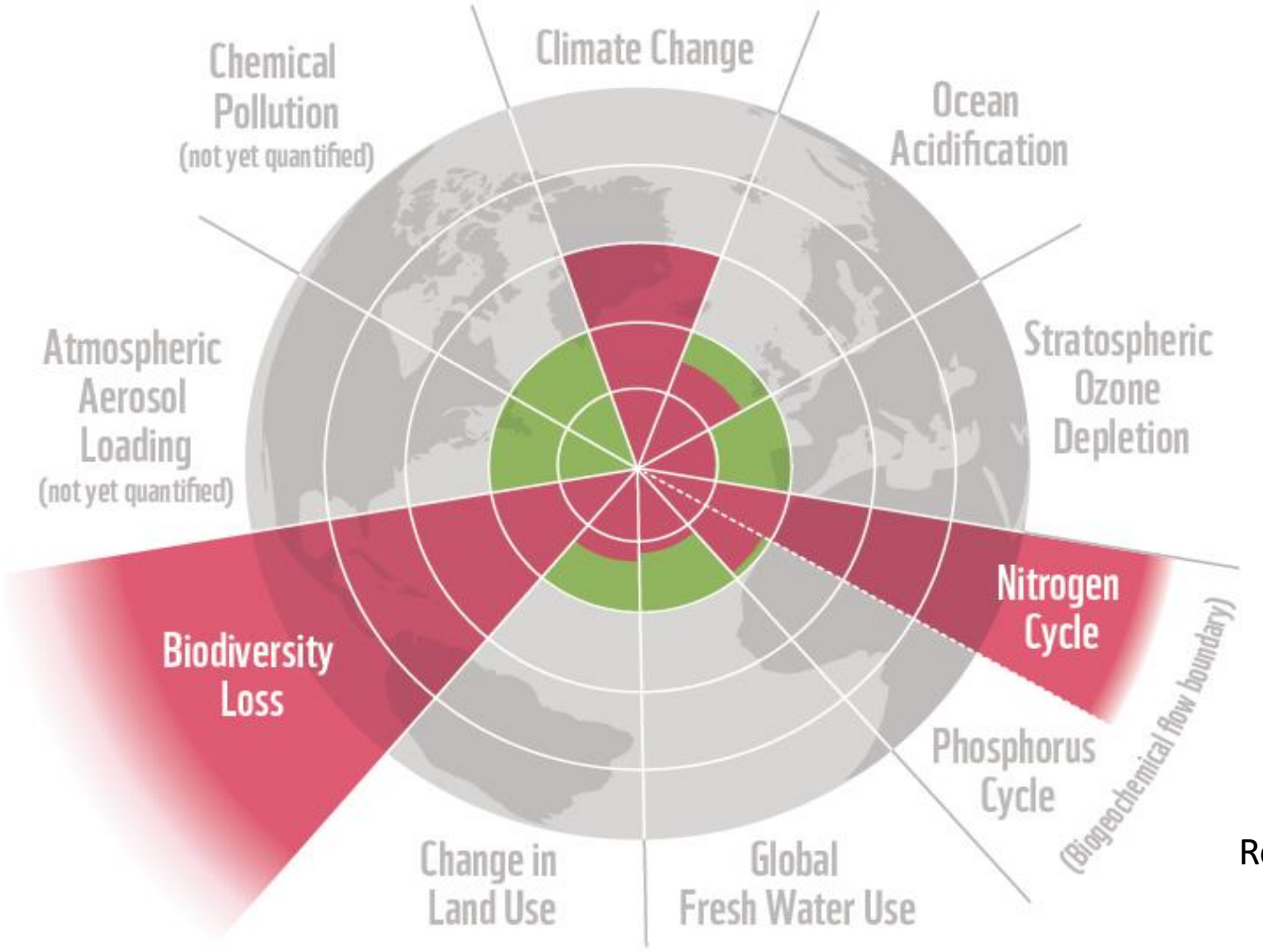
Why care about nitrogen?

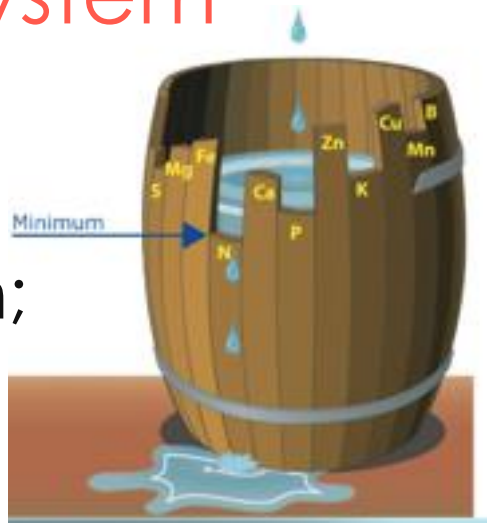


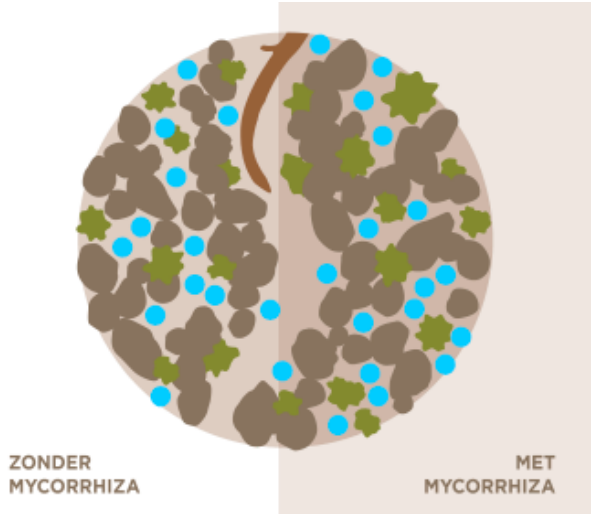
Rockström et al. 2009 Nature

Nitrogen changed our food system

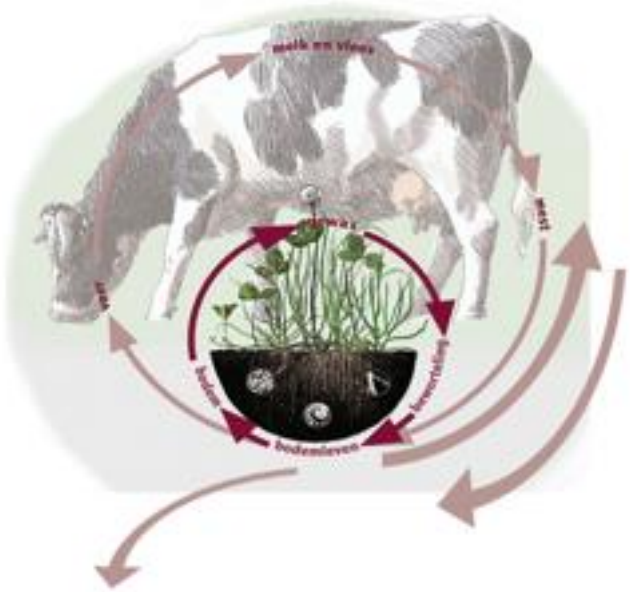
Natural N levels:
Rich biodiversity

More biomass
(= food):
more nitrogen;
Haber-Bosch





Soil life
unused



Law of diminishing
returns;
Increasing
environmental
losses

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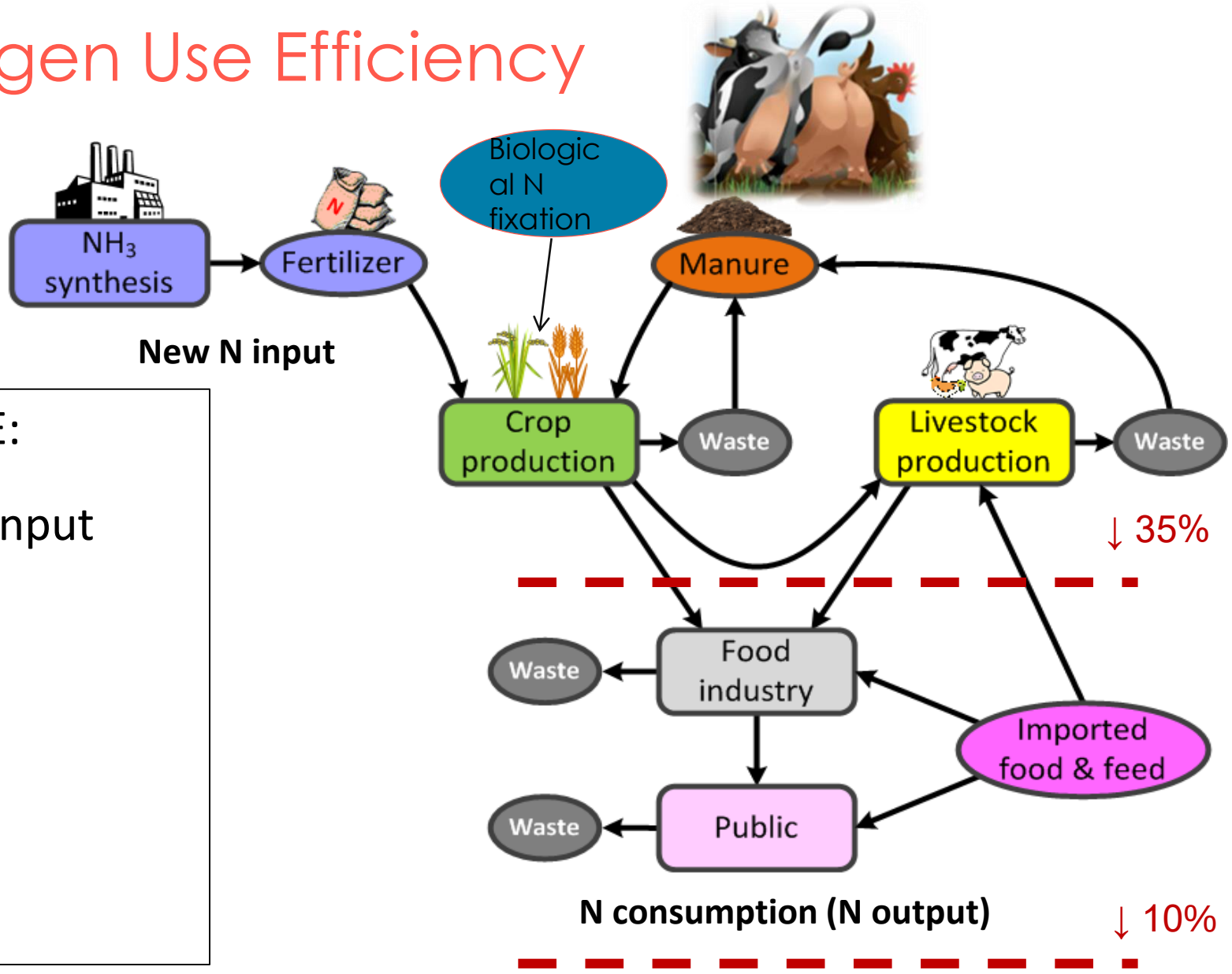
Changes in meat production

14

Nitrogen Use Efficiency

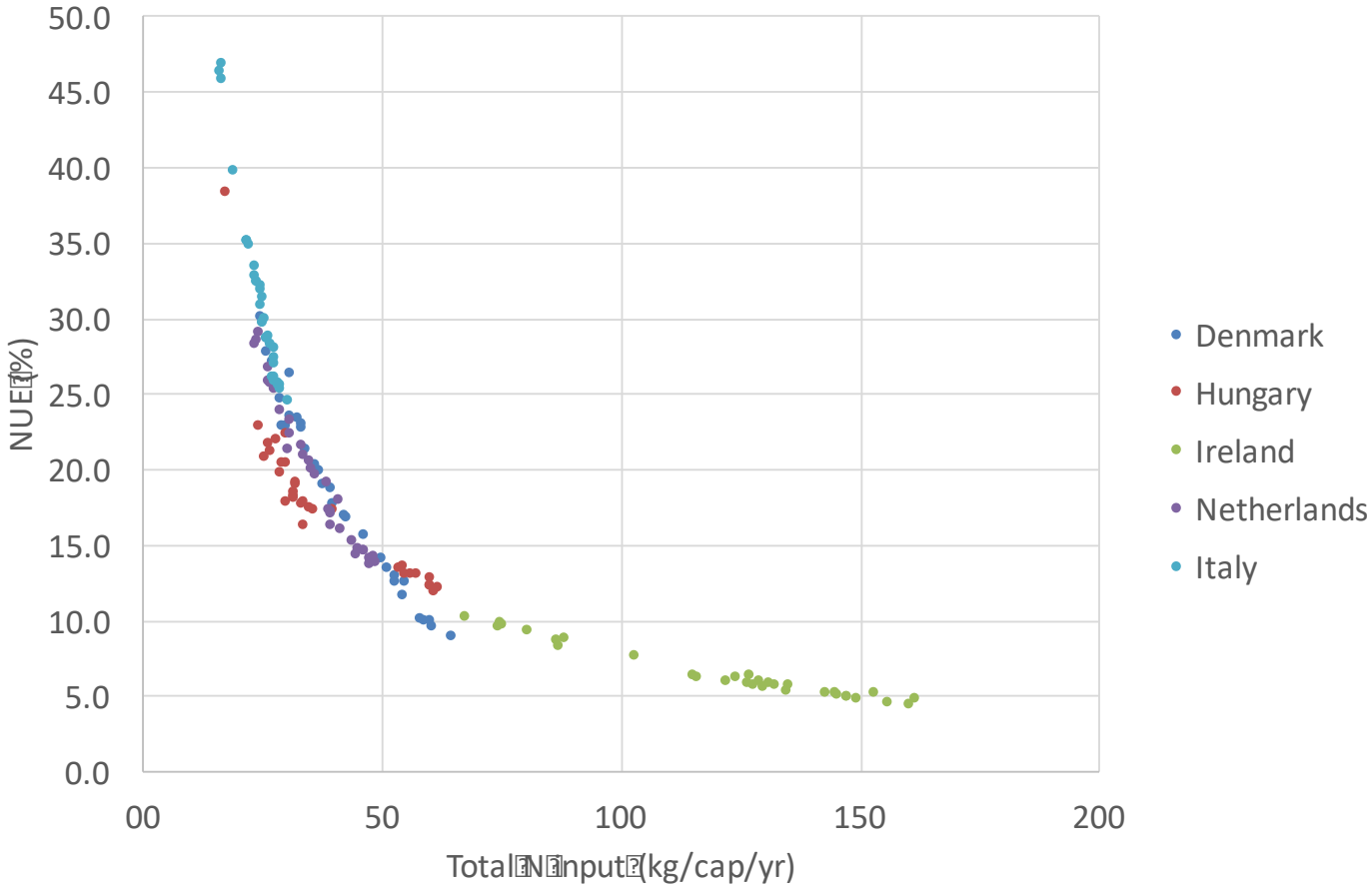


Nitrogen Use Efficiency, NUE:

NUE = N consumed/New N input

New N input:
- Fertilizer
- BNF
- Transport/energy
- Import - export
- Natural deposition

NUE higher with lower per capita input



Erisman et al. 2017

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The impact of food choices on a N footprint

ENVIRONMENT

ENVIRONMENT

½ cup beans
15 g protein

3 oz steak
15 g protein

Leach et al., 2012

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Nitrogen effects: fertilization the biosphere

N-poor semi-natural ecosystems

Biodiversity forest

lichens

herb-rich grasslands

pristine rivers

N-rich ecosystems

Loss of: forest biodiversity

liches

monoculture grasslands

fish dieback

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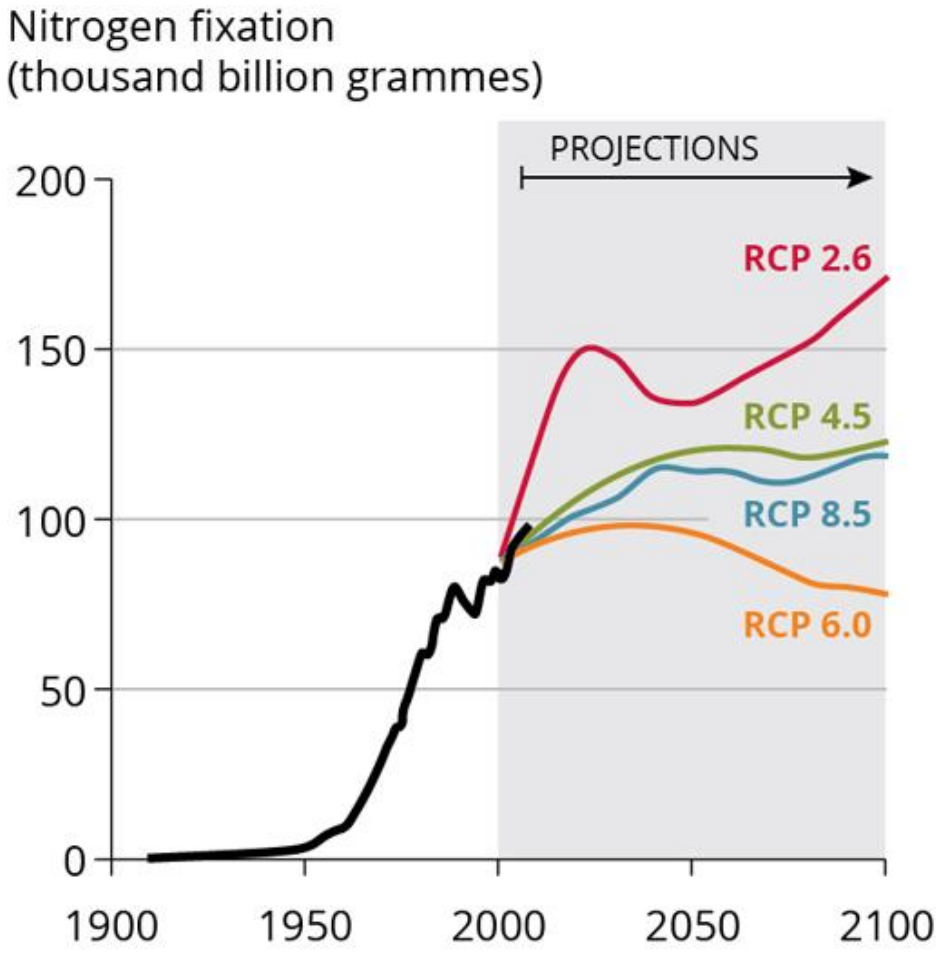
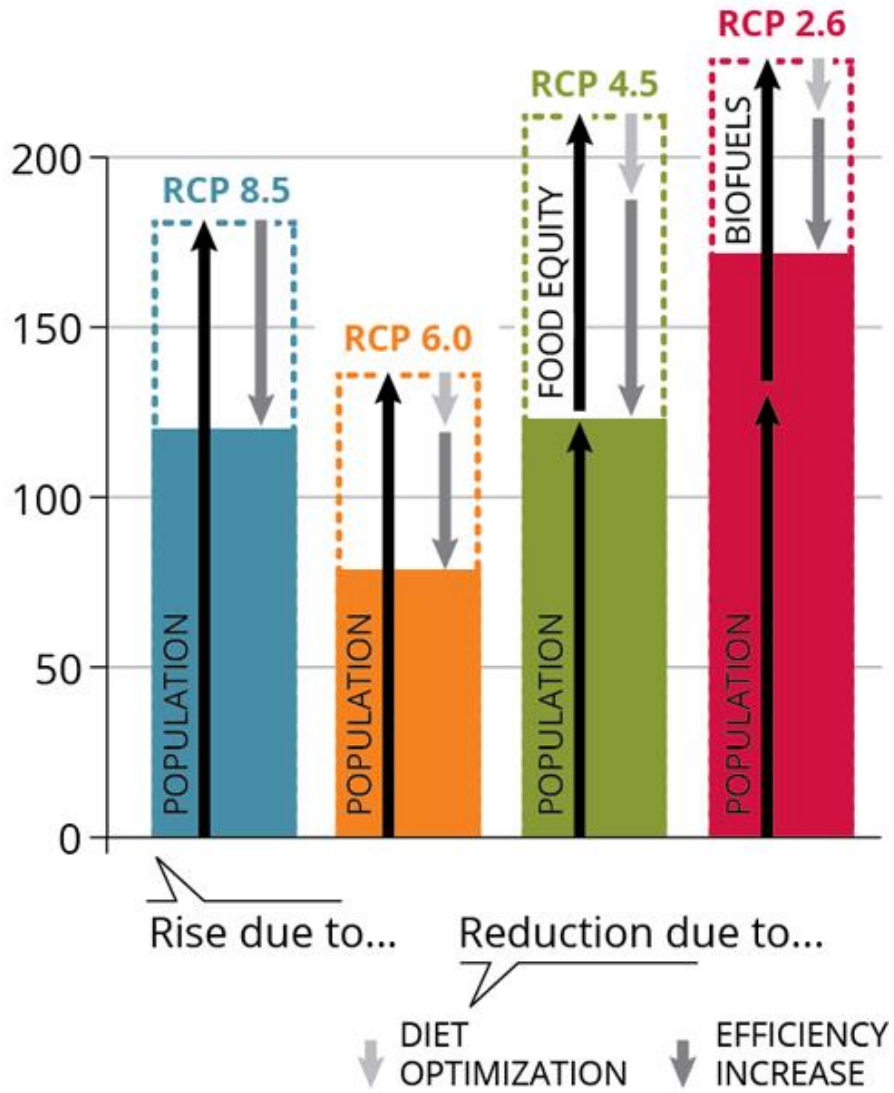
Nitrogen stimulates all growth

David,
Michelangelo Buonarroti (1475 - 1564)

Global Fertilizer N Demand by RCP (climate scenario)





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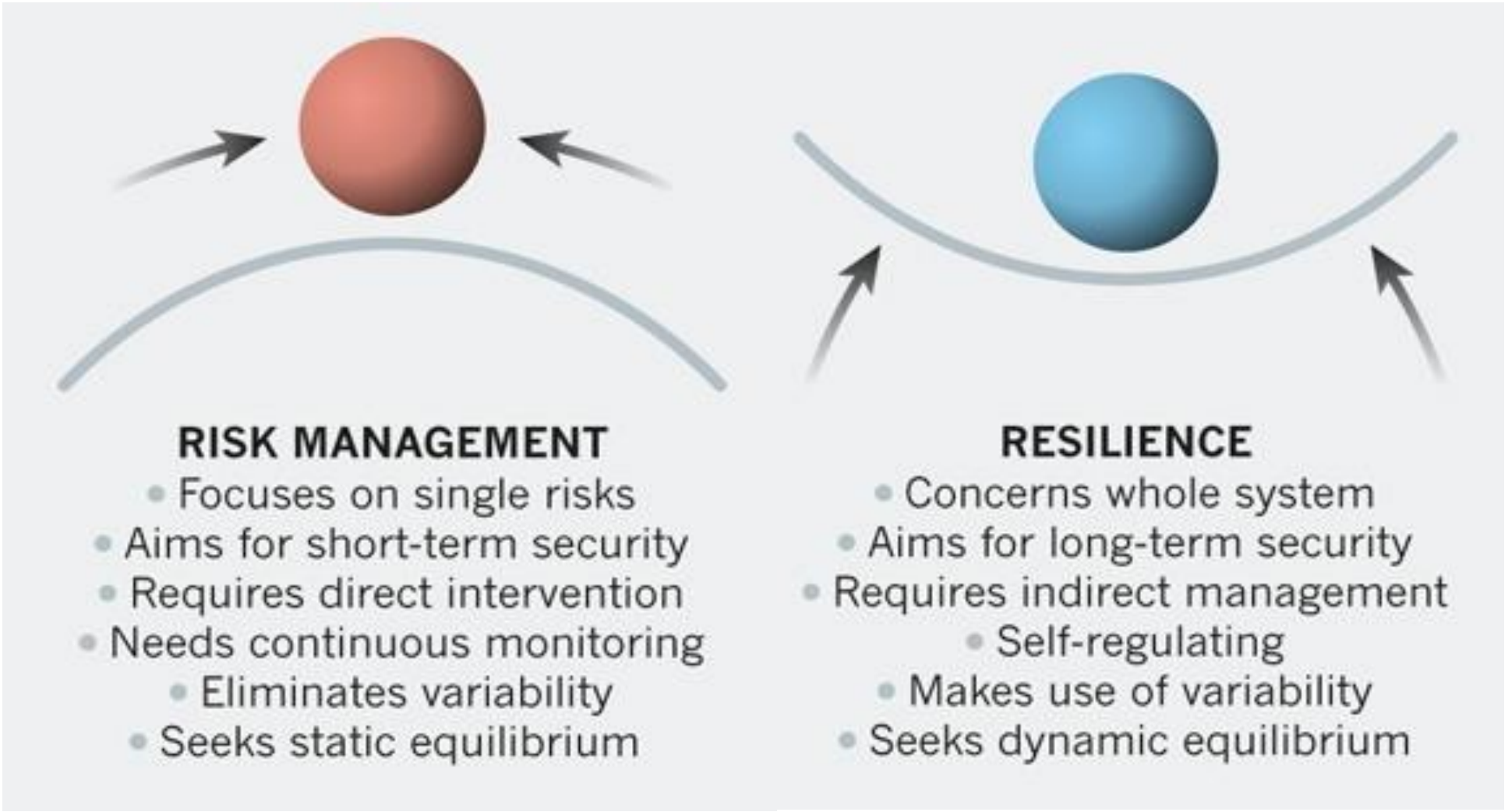
Risk management and resilient system



Erisman et al 2015, *Nature*

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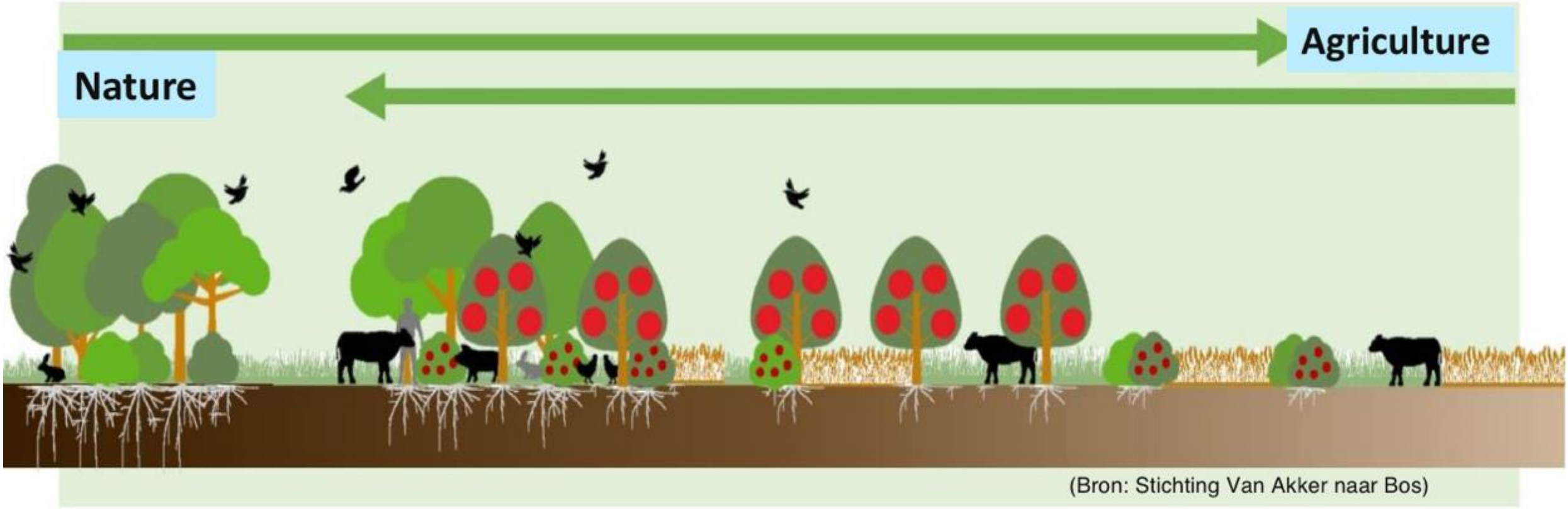
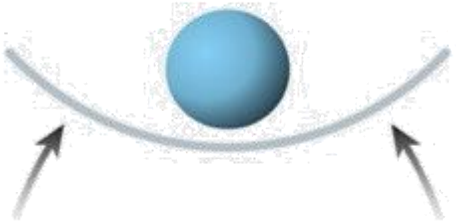
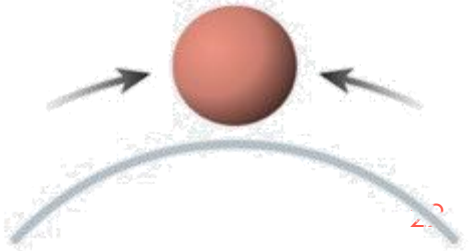
Nature based agriculture





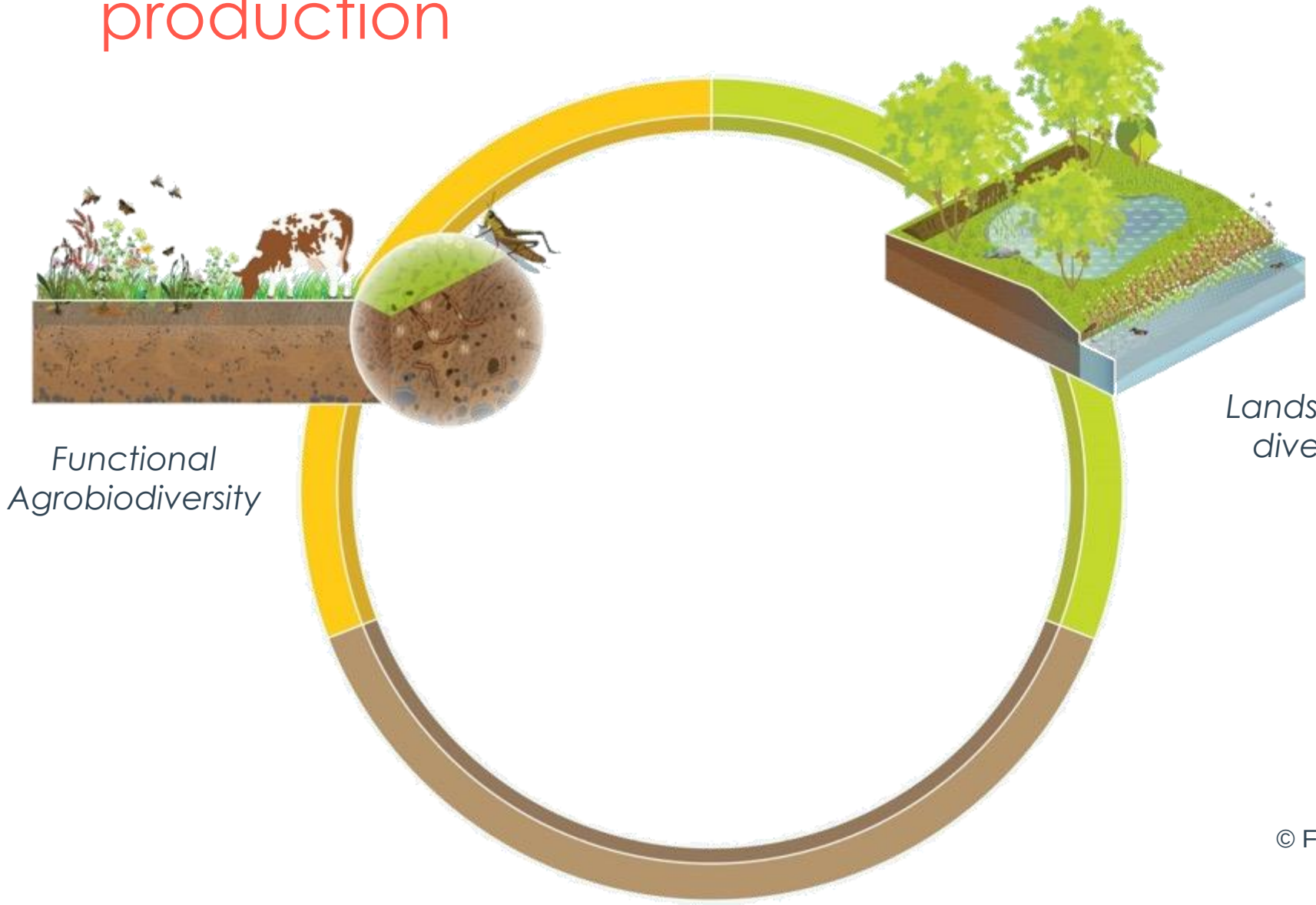
Soil, landscape and hydrology to determine food production system



Nature based / agroecological food production

Functional Agrobiodiversity

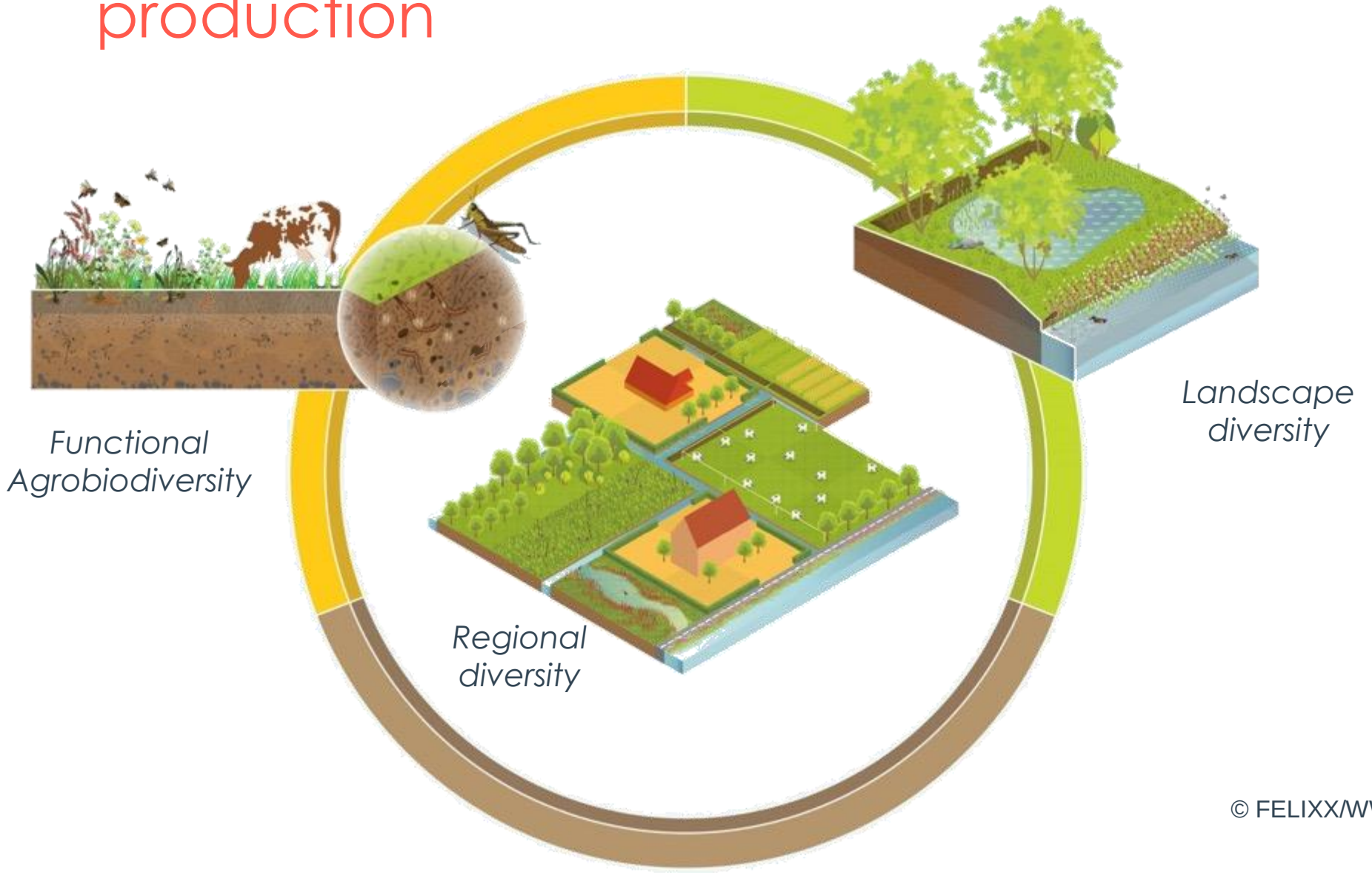
Nature based / agroecological food production



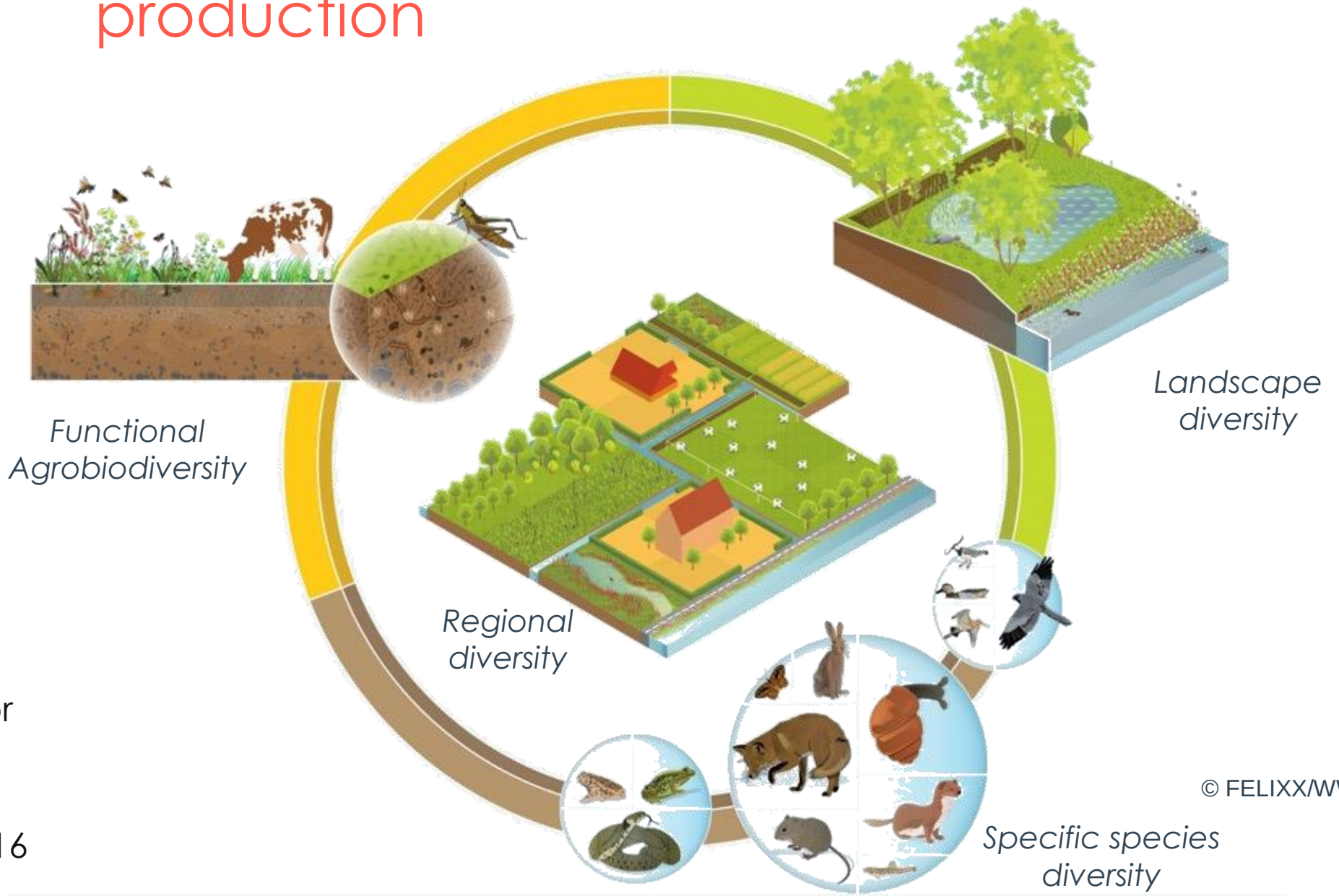
Functional Agrobiodiversity

Landscape diversity

Nature based / agroecological food production



Nature based / agroecological food production



Biodiversity monitor

Erisman et al. 2016

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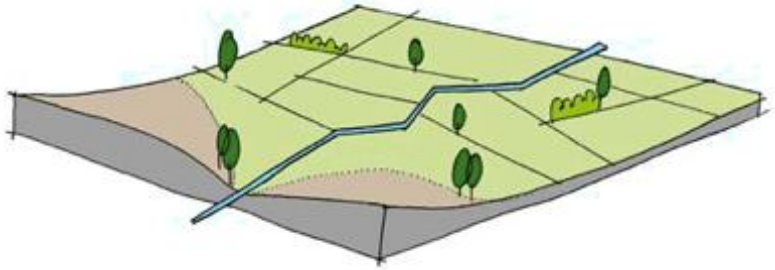
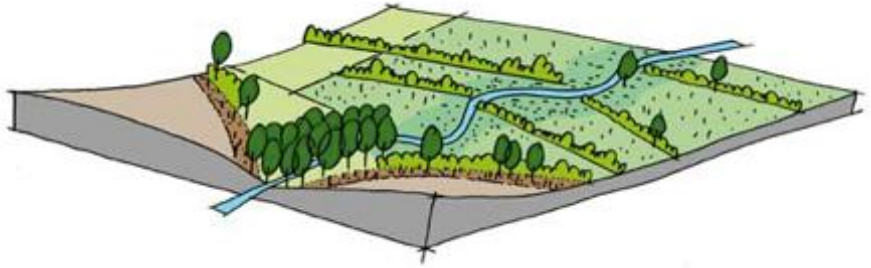
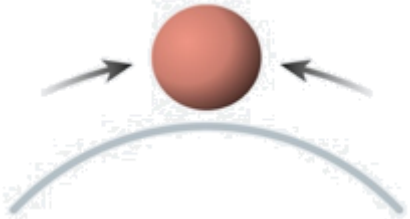
Businessmodels and landscape diversity







Four strategies to more sustainability for N cycling

Smarter diets

- Healthier diets
- Less animal products
- Less waste

Conceptual framework biodiversity in agriculture

Erisman et al (2016)

8th GLOBAL NITROGEN CONFERENCE

3rd – 7th MAY 2020 | BERLIN, GERMANY

REGISTER NOW

Thank you for your attention

j.erisman@louisbolk.nl

SUSTAINABLE DEVELOPMENT GOALS

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Summary

- Nitrogen management requires finding a balance between biosphere capacity and human needs
- The focus should be on strengthening our **adaptive capacity** (resilience)
- Nature based agriculture can be a basis for sustainable agriculture using the conceptual framework and diverse systems