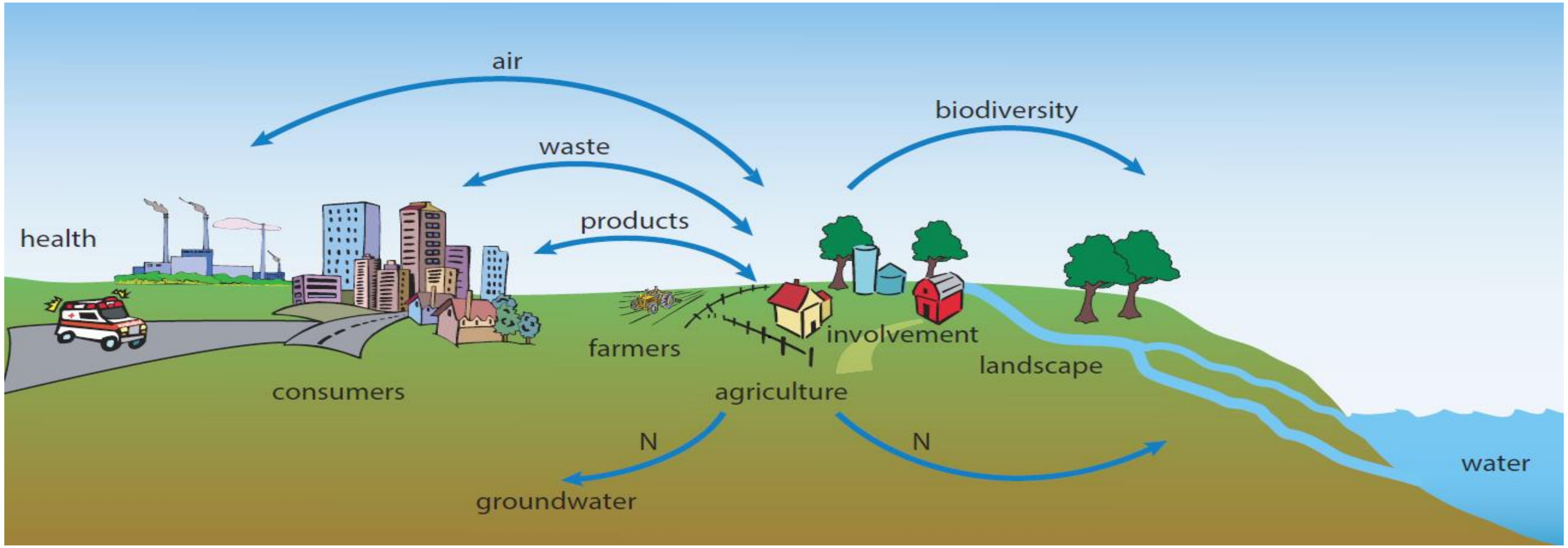
Landscape measures to improve livestock systems nitrogen management and planning



Tommy Dalgaard. Aarhus University, Department of Agroecology

70th Annual meeting of the European Federation of Animal Science. Session 31: How to address tradeoffs and synergies in livestock farming systems? Ghent, Belgium, 27 August 2019.

UNECE Task Force on Reactive Nitrogen

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dNmark research alliance

Programme

- **Introduction**
  - Landscape management for improved nitrogen ressource efficiency; synergies and tradeoffs
  - Challenges in (Danish) livestock farming
- **Research results**
  - Examples from European landscape studies
  - Specific lessons from a Danish study landscape
- **Discussion and conclusions**

Livestock farming and the nitrogen cascade

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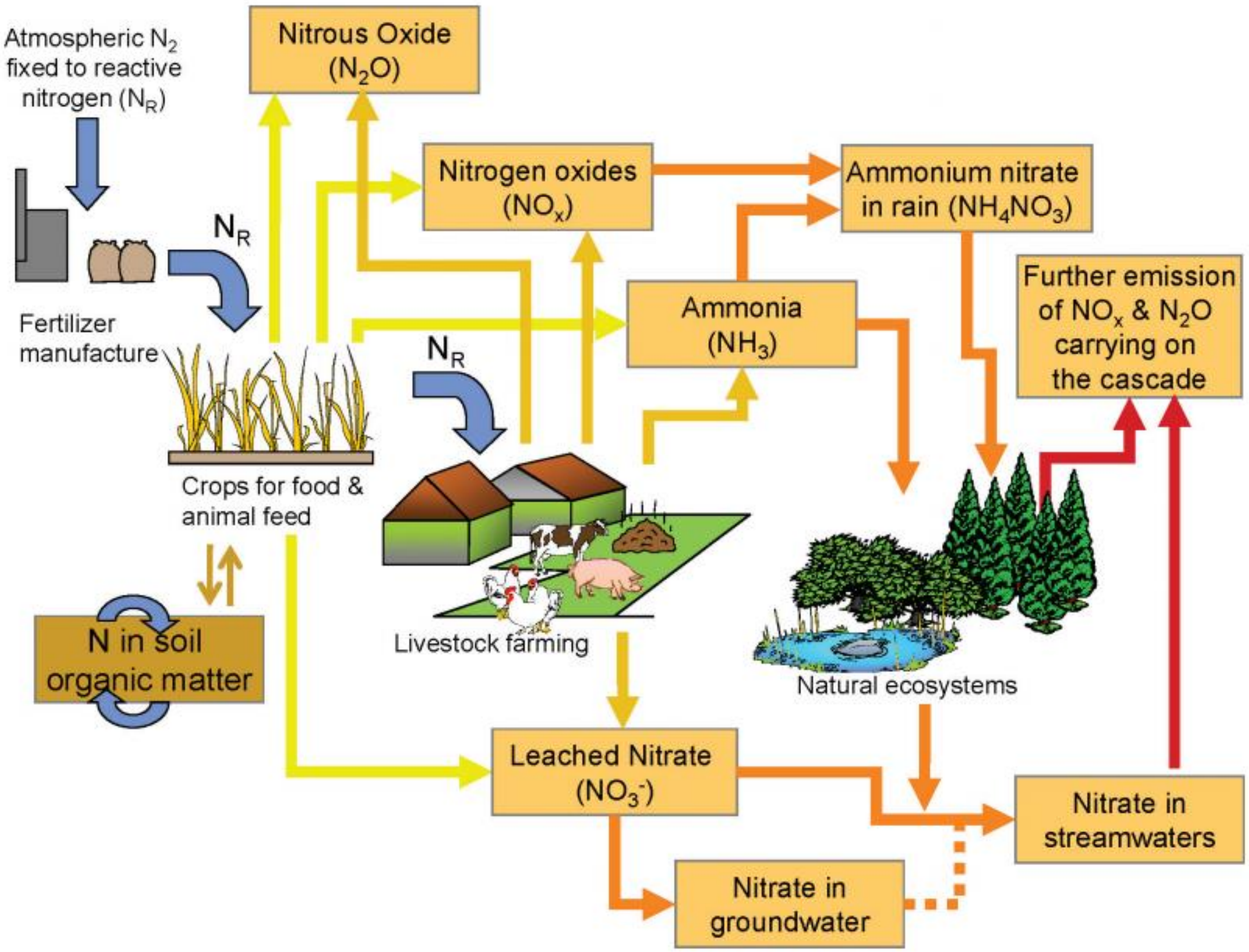
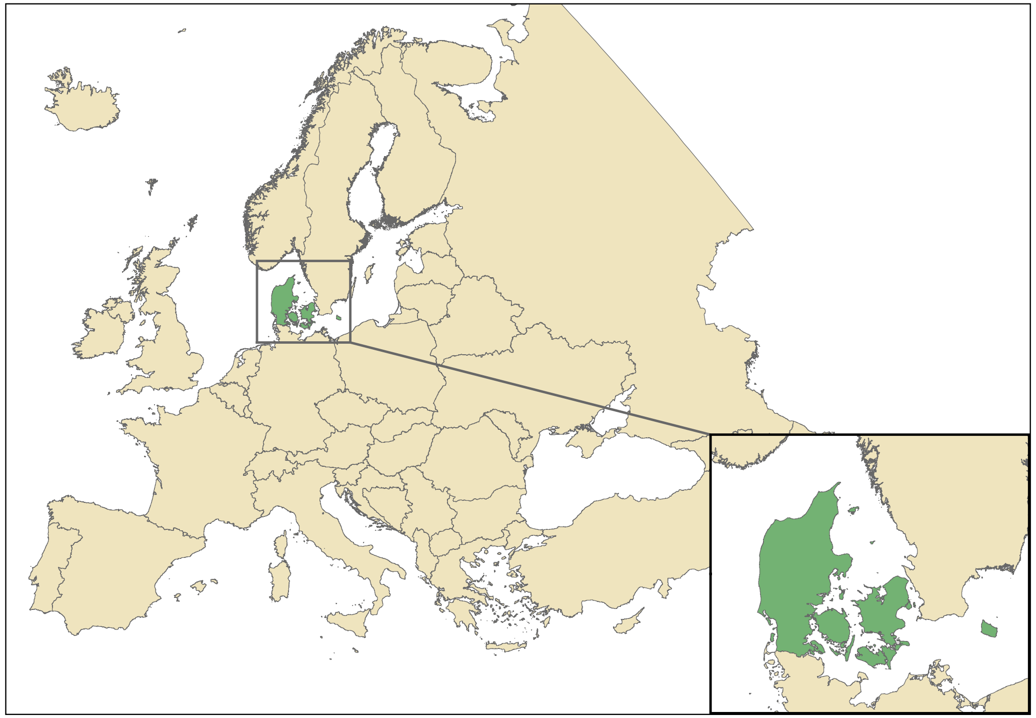


European Nitrogen Assessment, Cambridge University Press 2011

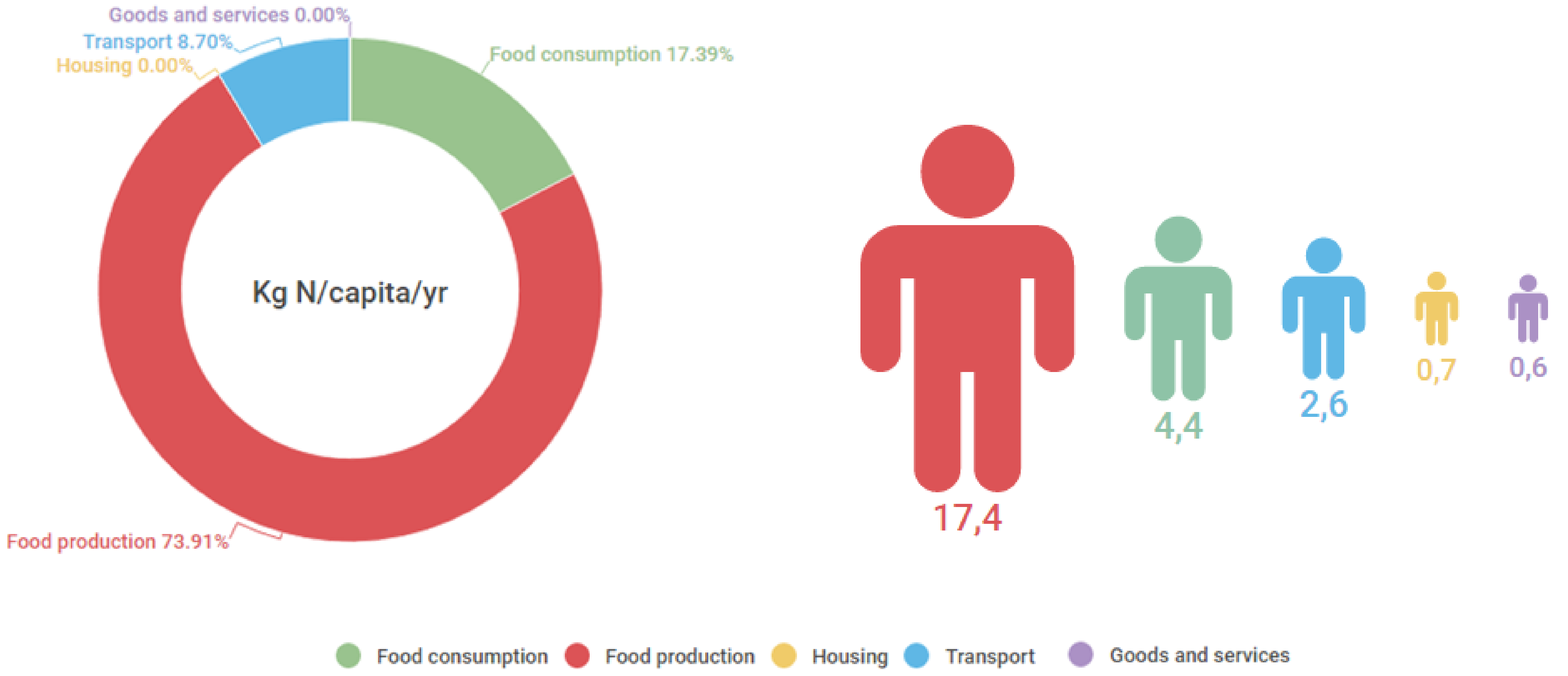
Agriculture and livestock farming in Denmark

- 2.6 mio ha agricultural land (61% of total area)
- 5.6 mio people – 4.5 mill. t milk, 30 mill. pigs/yr (from this 13 mio piglets exported)

- Produce 3 times our own food consumption
- 10 t milk/cow/yr
- 31 piglets/sow/yr
- 8 t wheat/ha/yr
- >8% organic agriculture
- 7500 km coastline



The Danish Nitrogen footprint



Graversgaard *et al.* (2018)

N surplus & efficiency in Danish agriculture

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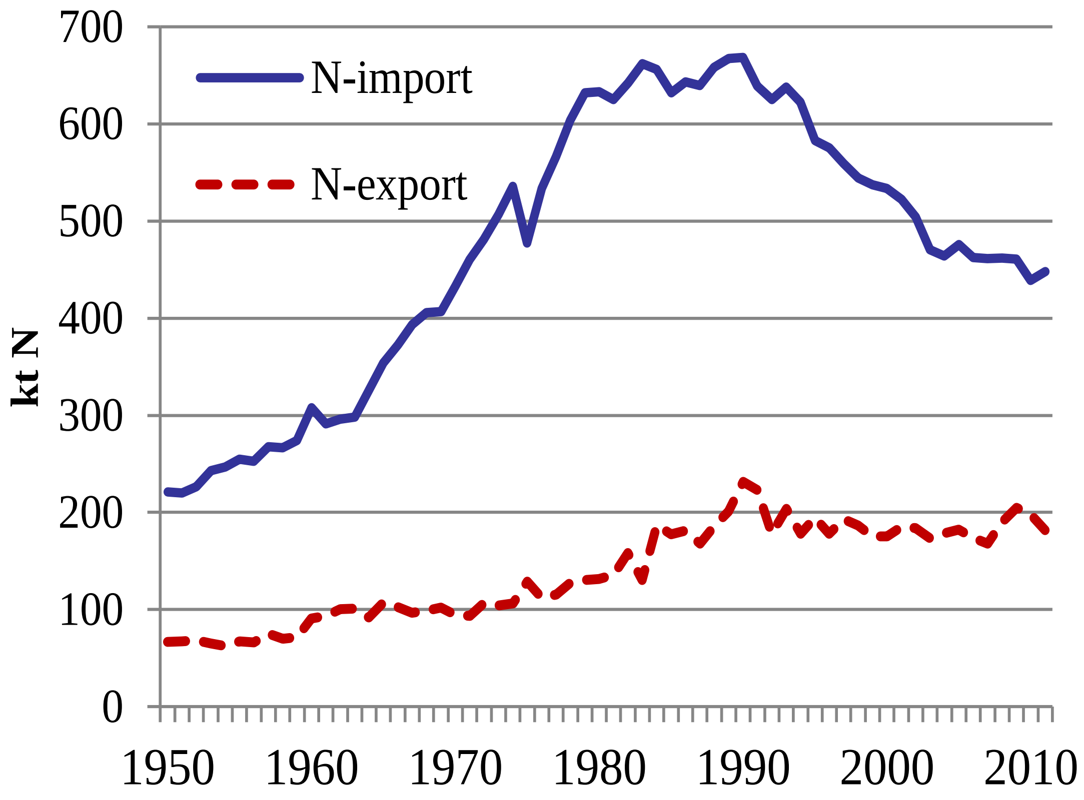
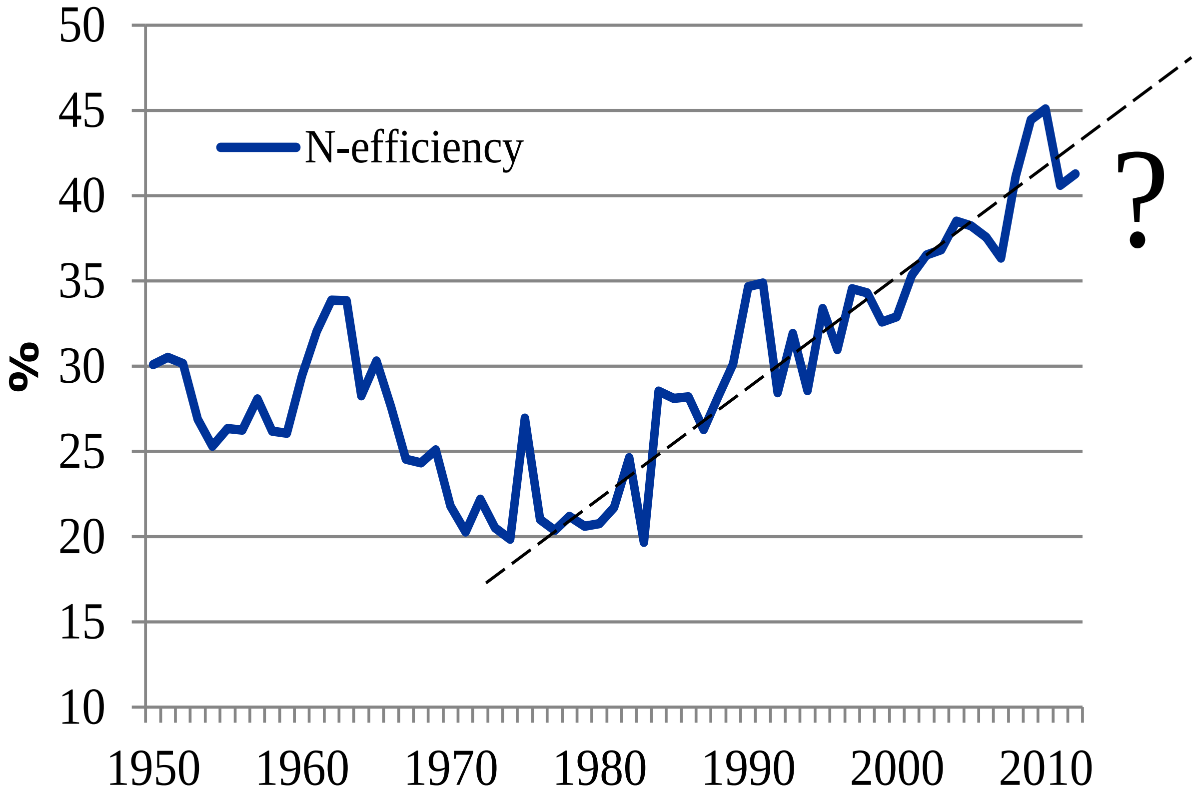
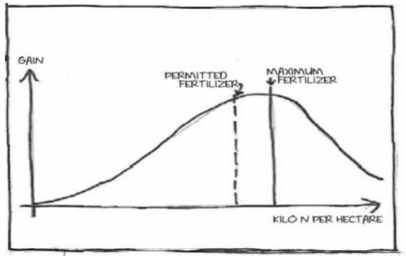


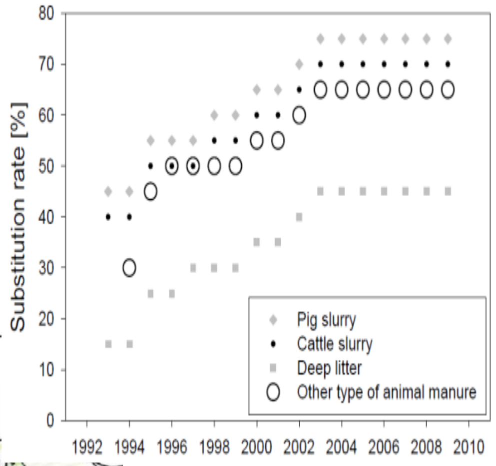


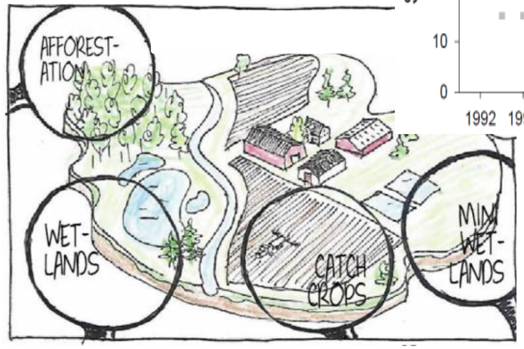
Dalgaard *et al.* Env. Research Letters 9 (2014)

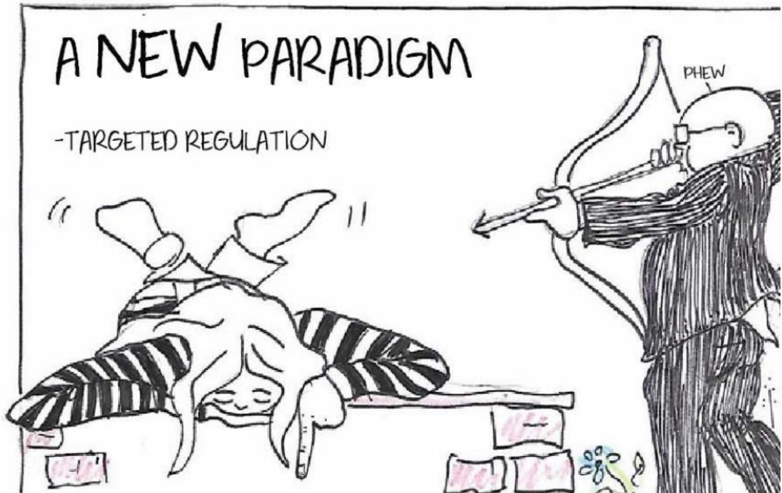
N management Action Plans (AP) in DK

- 1970'es: Urban wastewater treatment
- 1985: NPo plan (point sources etc.)
- 1987: AP-I (50% N-leaching red. target)
- 1991: AP Sust. Agriculture (N budgets)
- 1998, 2000: AP-II (N-norm below optimum)
- 2001: Ammonia AP (cover, no broadcast)
- 2004: AP-III (higher manure NUE)
- 2009: Green Growth
- 2014 1st EU WFD River Basin Management Plan (N norm≈ 21% < economic optimum in 2015)
- 2016: Agricultural package (back to economic optimum + targeted regulation)









European landscape case studies

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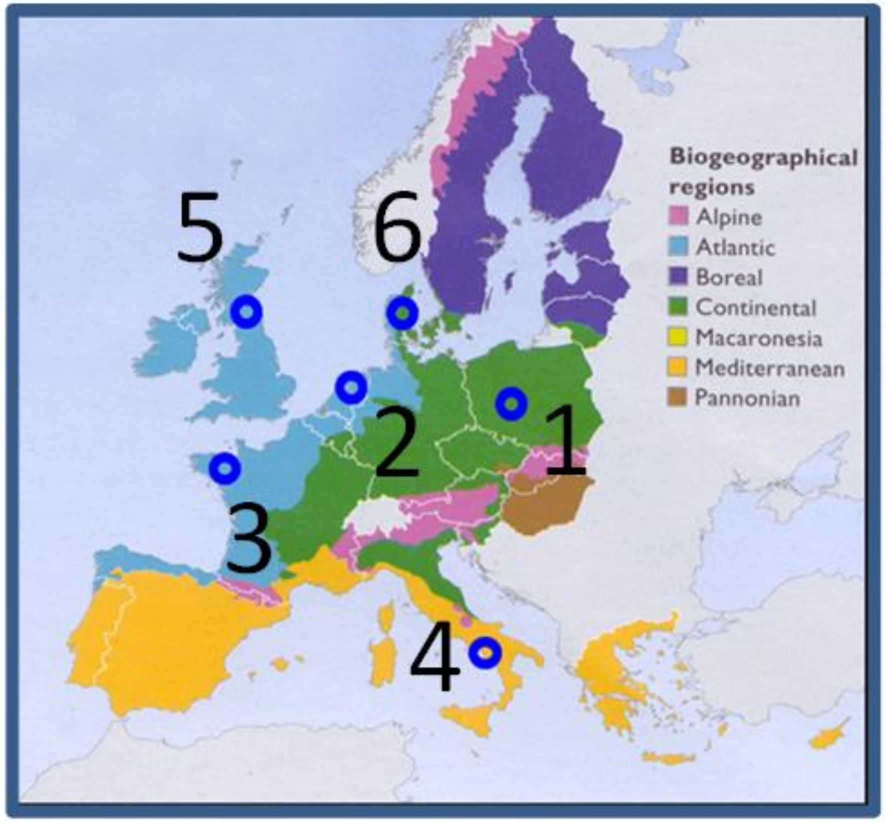
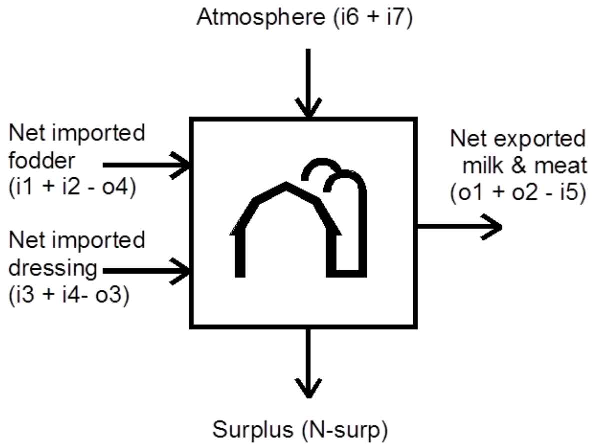


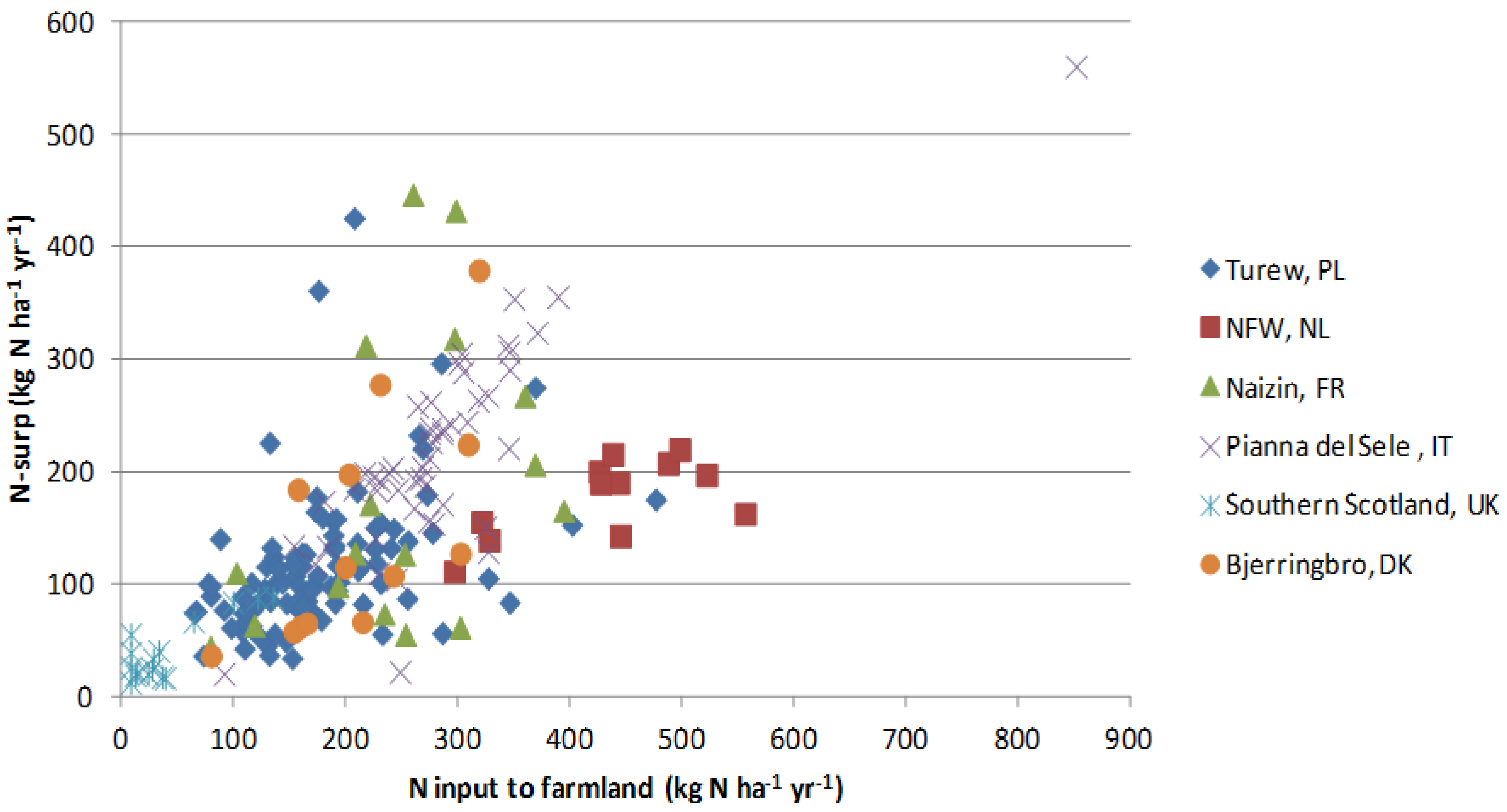
NitroEurope IP

Highest N-surplus in most livestock intensive landscapes



N-inputs:
i1= imported fodder
i2= imported seeds
i3= imported fertilisers
i4= imported manure
i5= imported animals
i6= deposited atmospheric N
i7= fixed atmospheric N

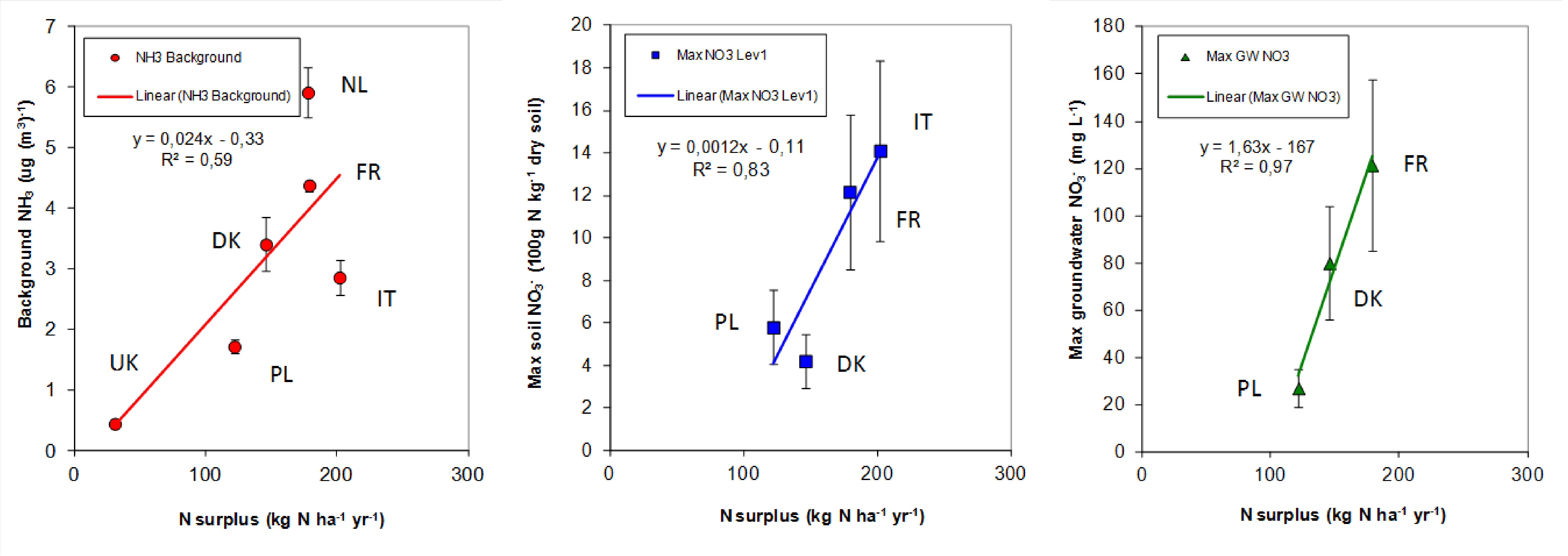
N-outputs:
o1= exported milk
o2= exported meat
o3= exported manure
o4= exported sales crops



Dalgaard et al. (2012) Biogeosciences 9

Background emissions related to N surplus

(NH_3, max soil NO_3^-, max groundwater NO_3^-)

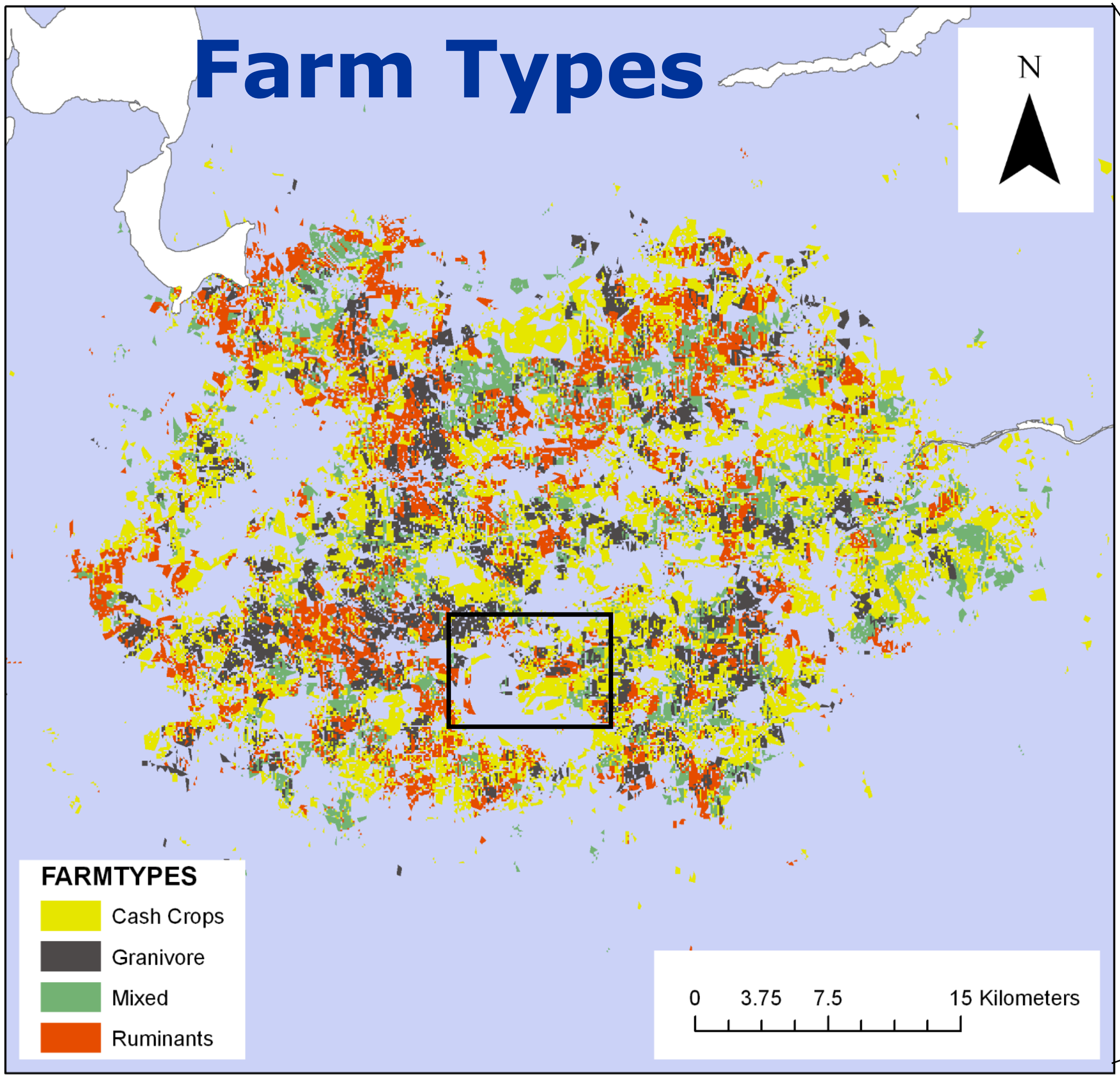


Example from the Danish landscape

- with different farm types, livestock systems and intensities

	Ruminants	Granivore	Mixed	Cash Crops > 10 kg manure-N/ha	 < 10 kg manure-N/ha
	(n=14)	(n=13)	(n=11)	(n=23)	(n=7)
Manure-N produced (kg N ab store ha-1 yr-1)	175 ±35	136 ±23	61 ±12	9 ±2	4 ±3
Manure-N spread (kg N ha-1 yr-1)	147 ±18	125 ±18	58 ±11	59 ±28	3 ±2
Fertiliser-N spread (kg N ha-1 yr-1)	30 ±14	44 ±11	97 ±10	86 ±22	130 ±14
Area with sandy soils (% of total area)	50	49	50	45	47

Data from 2002



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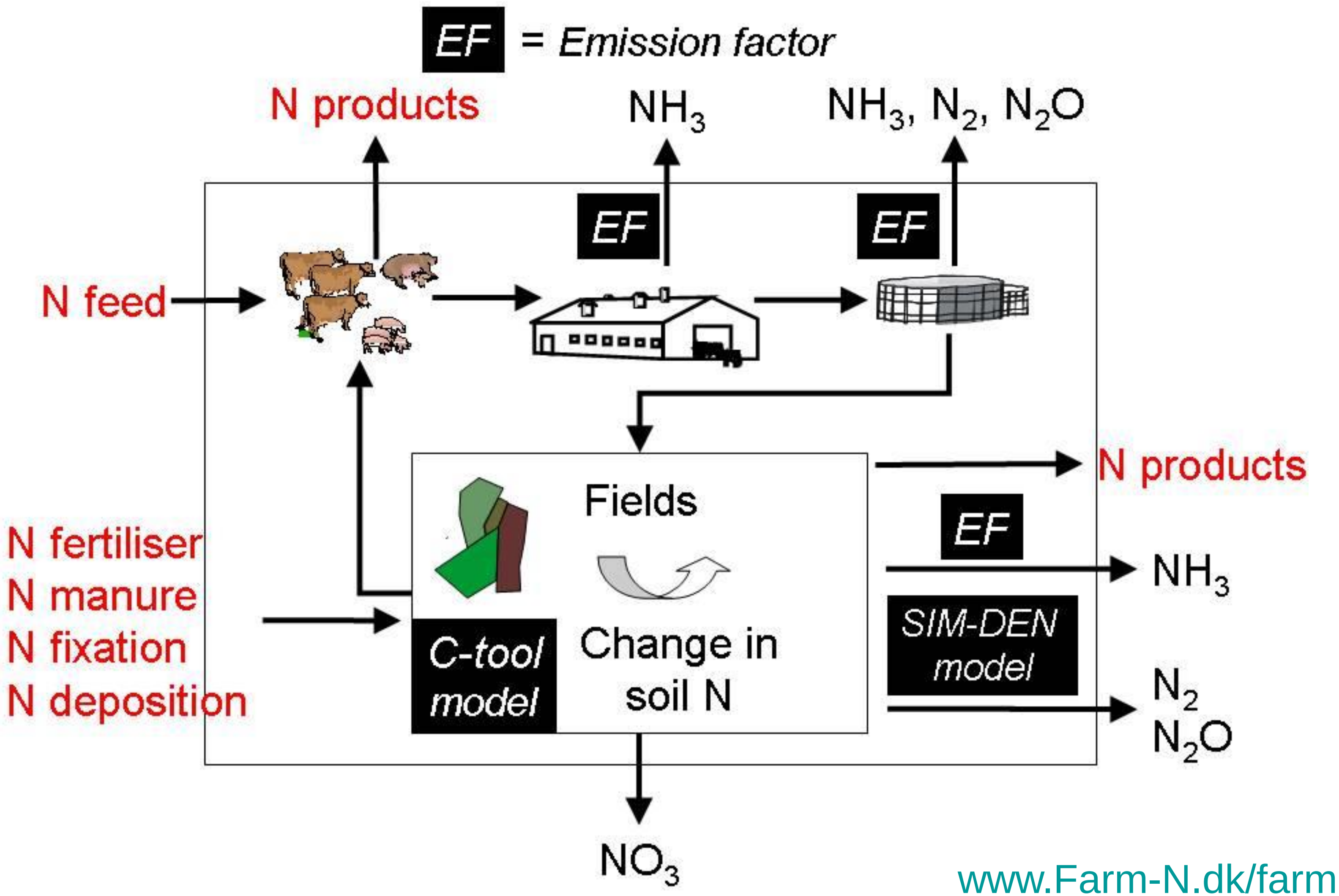
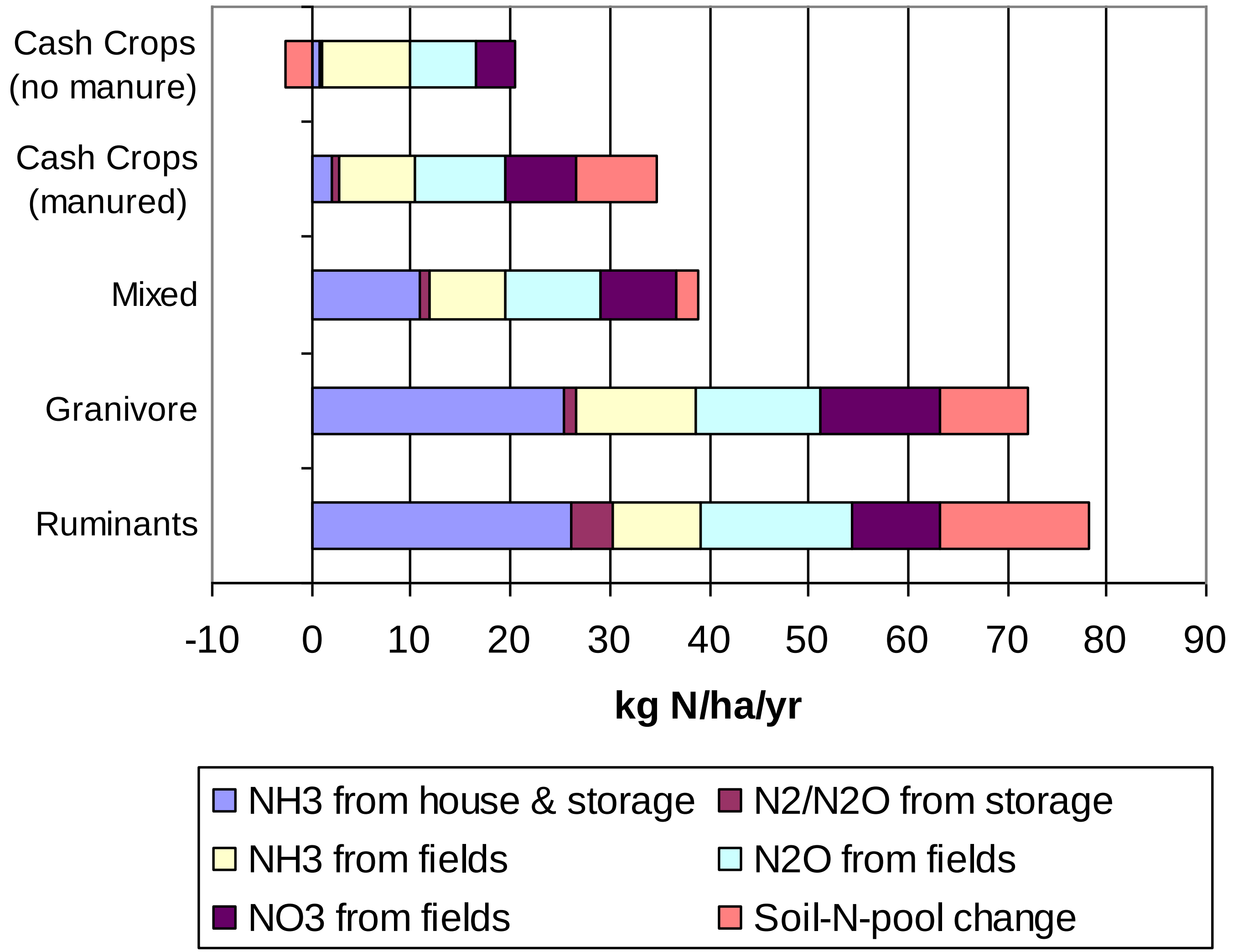
The Farm-N model



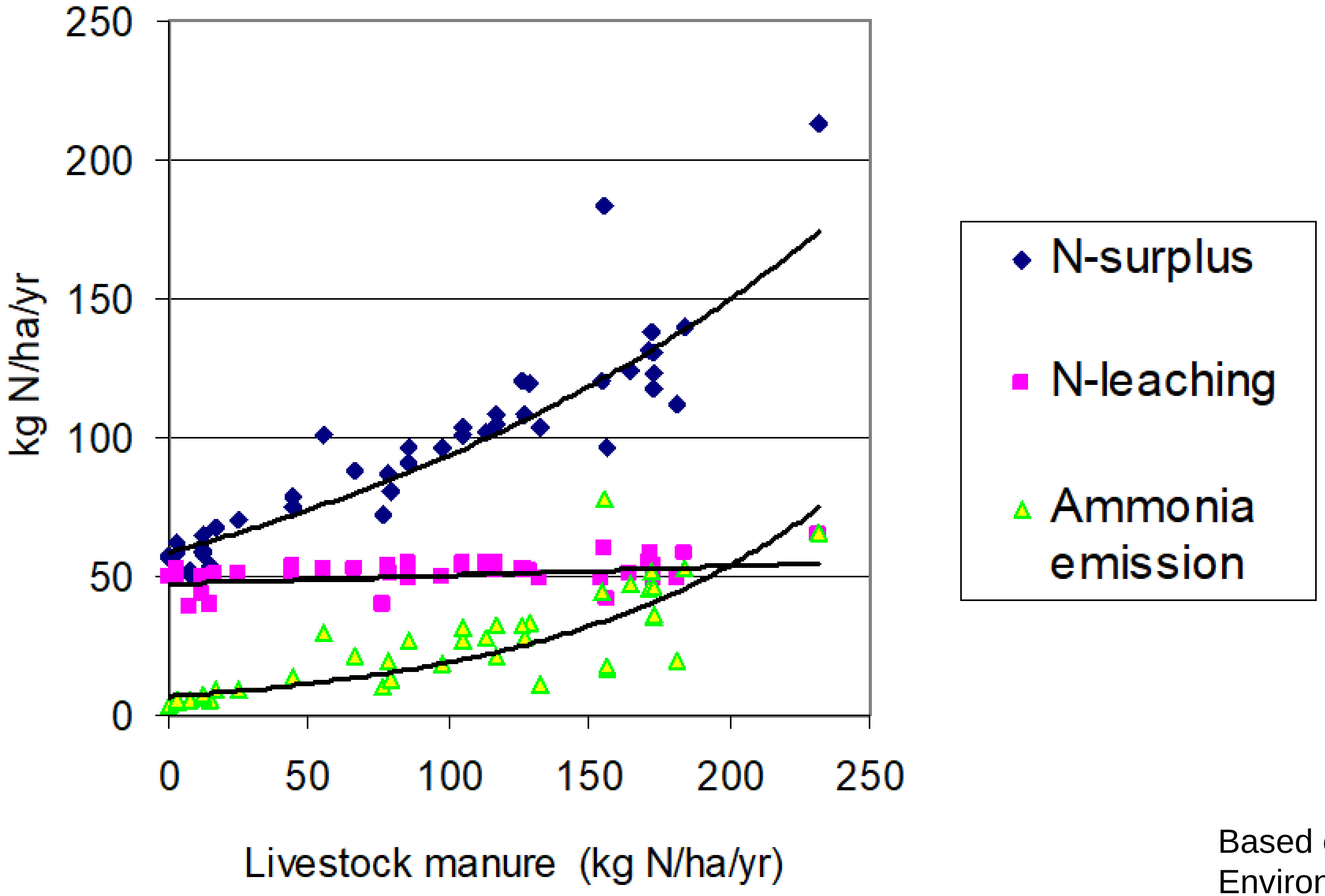
www.Farm-N.dk/farmNtool

Modelled farm gate N-balances



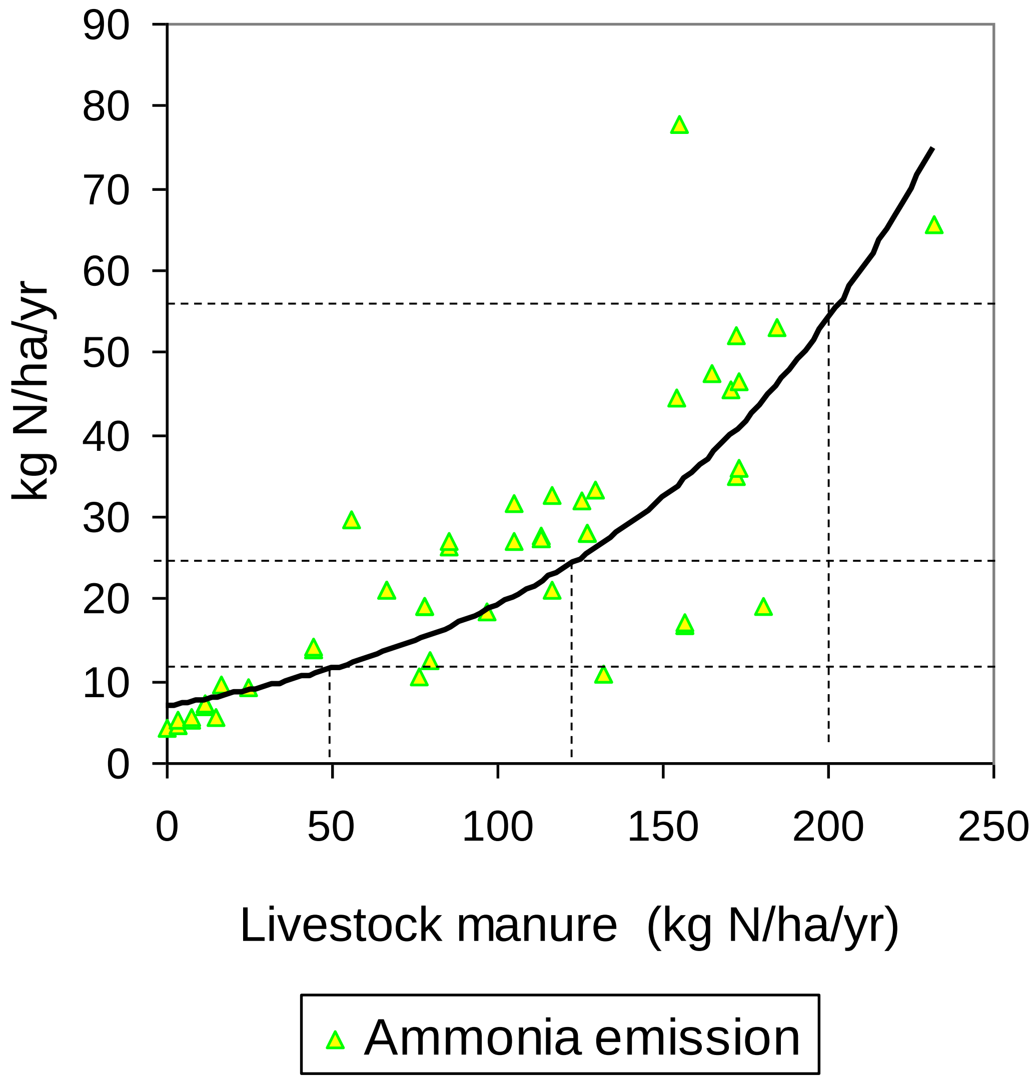
Dalgaard et al. (2011) Environmental Pollution 159, 3183-3192

Heterogeneity between farms



Based on Dalgaard et al. (2011)
Environmental Pollution 159, 3183-3192

Example: Potential effect of collaboration

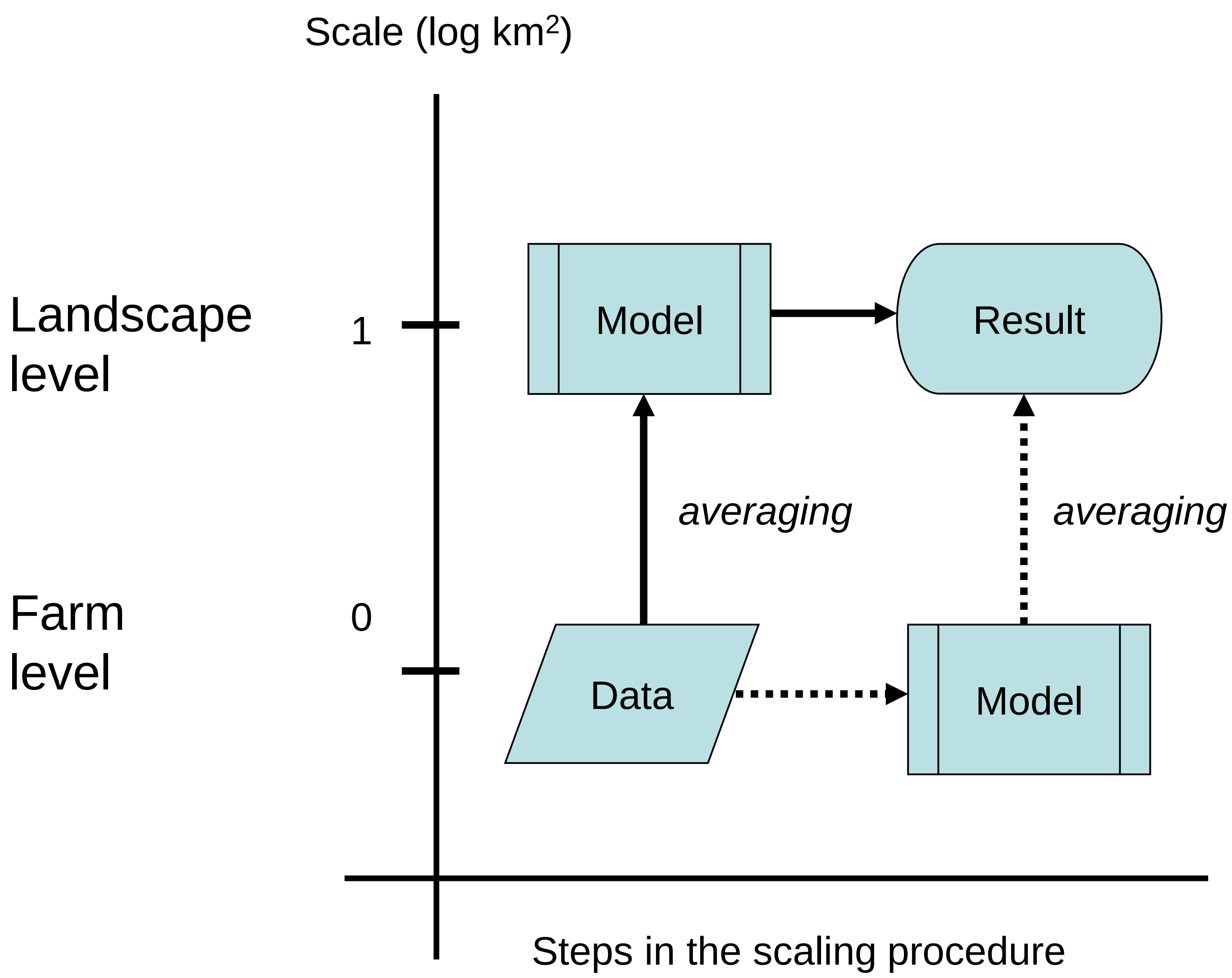


(55+12)/2= 33½

≠

26

Accounting effects of non-linearities and heterogeneity in modelling



After Kjeldsen et al. (2006)
Danish Journal of Geography 106(2)

The landscape scaling problem

Top down information
from national/regional statistics, Corine Land Cover etc.

Examples:

1) MEA-scope — ≈ 500 km^2 landscapes

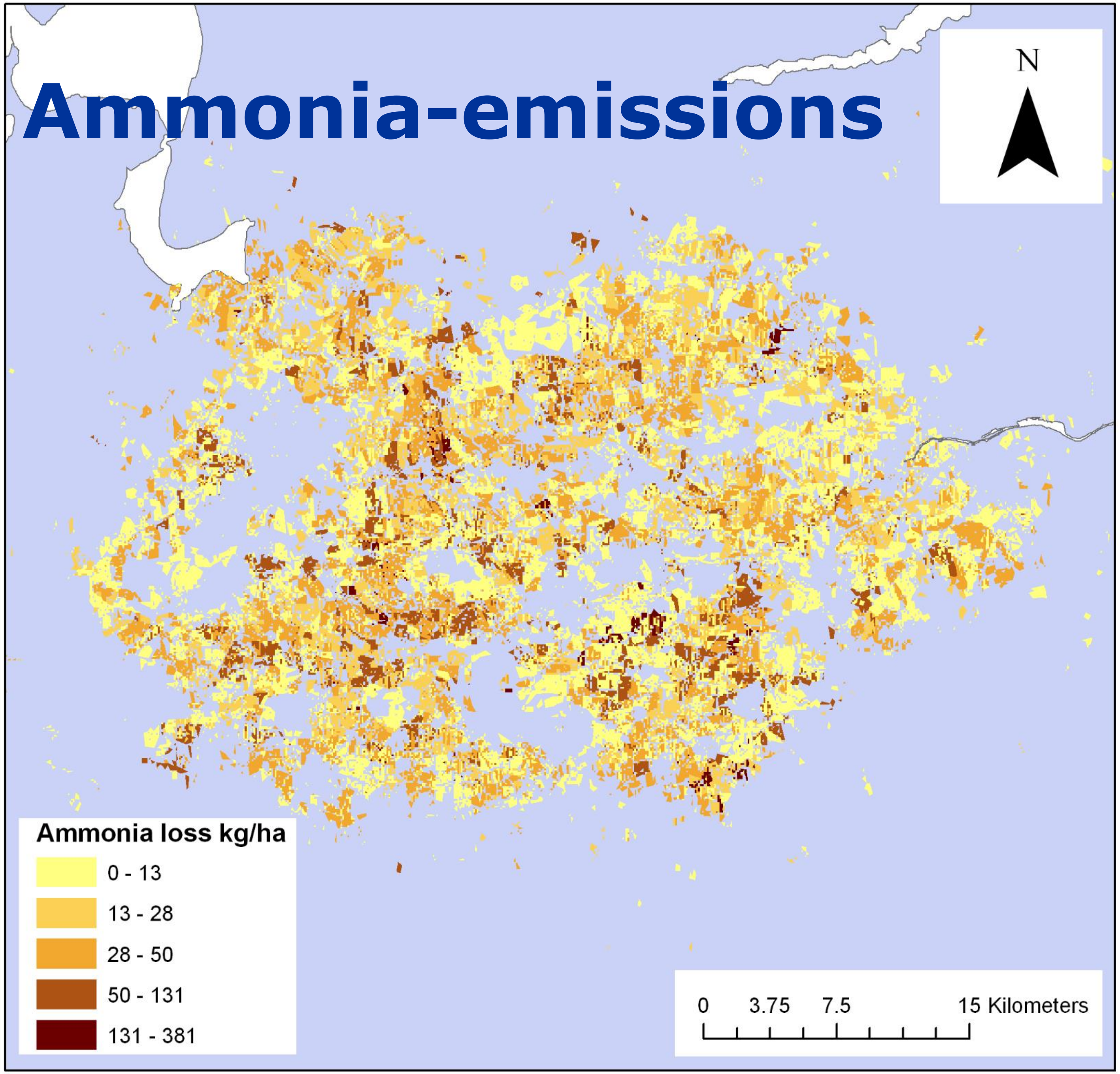
2) NitroEurope — ≈ 25 km^2 landscapes

3) New EU projects…

Bottom-up information
from local farm surveys, plot experiments, digital EU farm registers, local GIS-maps (LPIS, soil maps…) etc.

After Dalgaard et al. (2009) Springer Verlag, Berlin. DOI 10.1007/978-3-540-79470-7.

Ammonia-emissions



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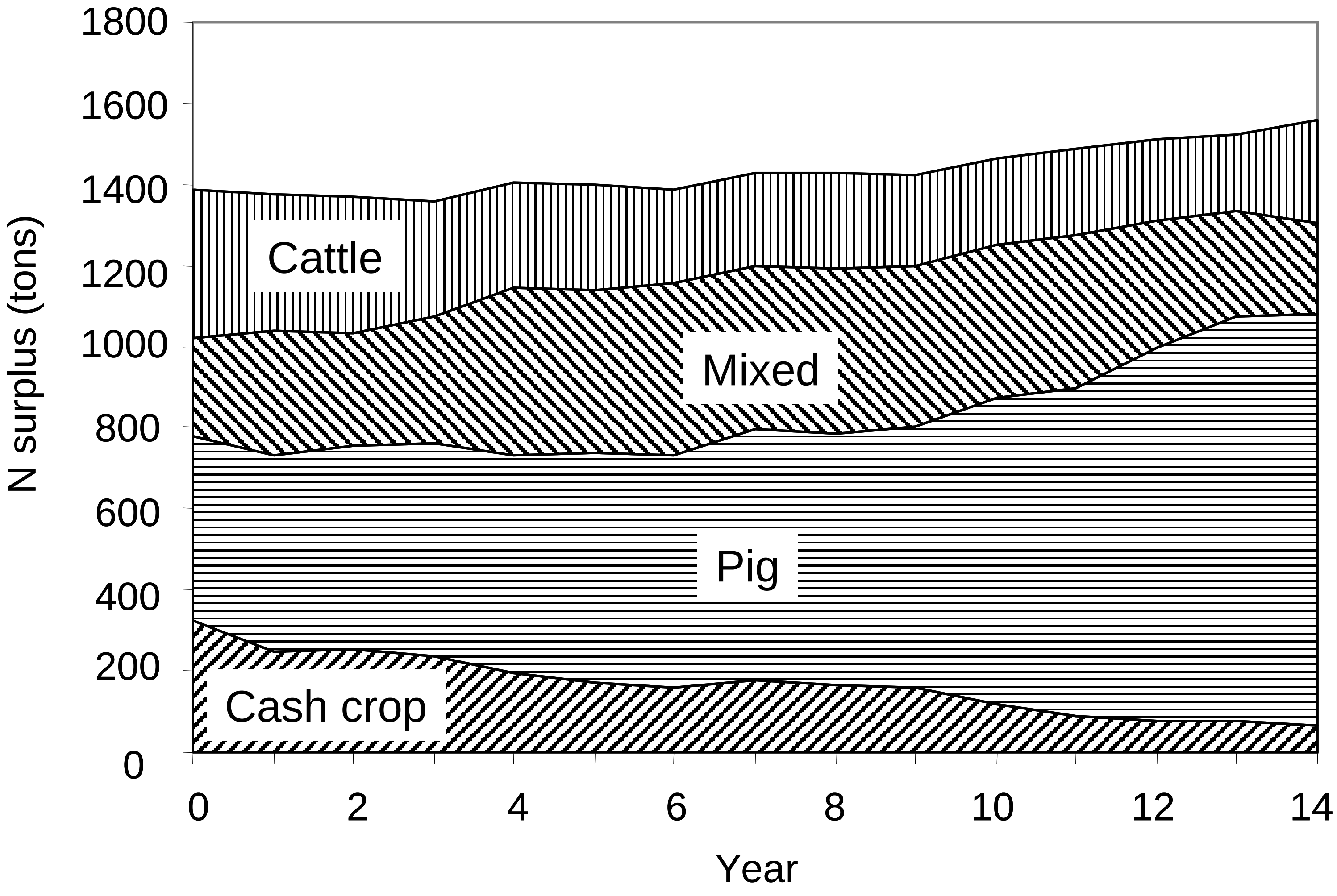
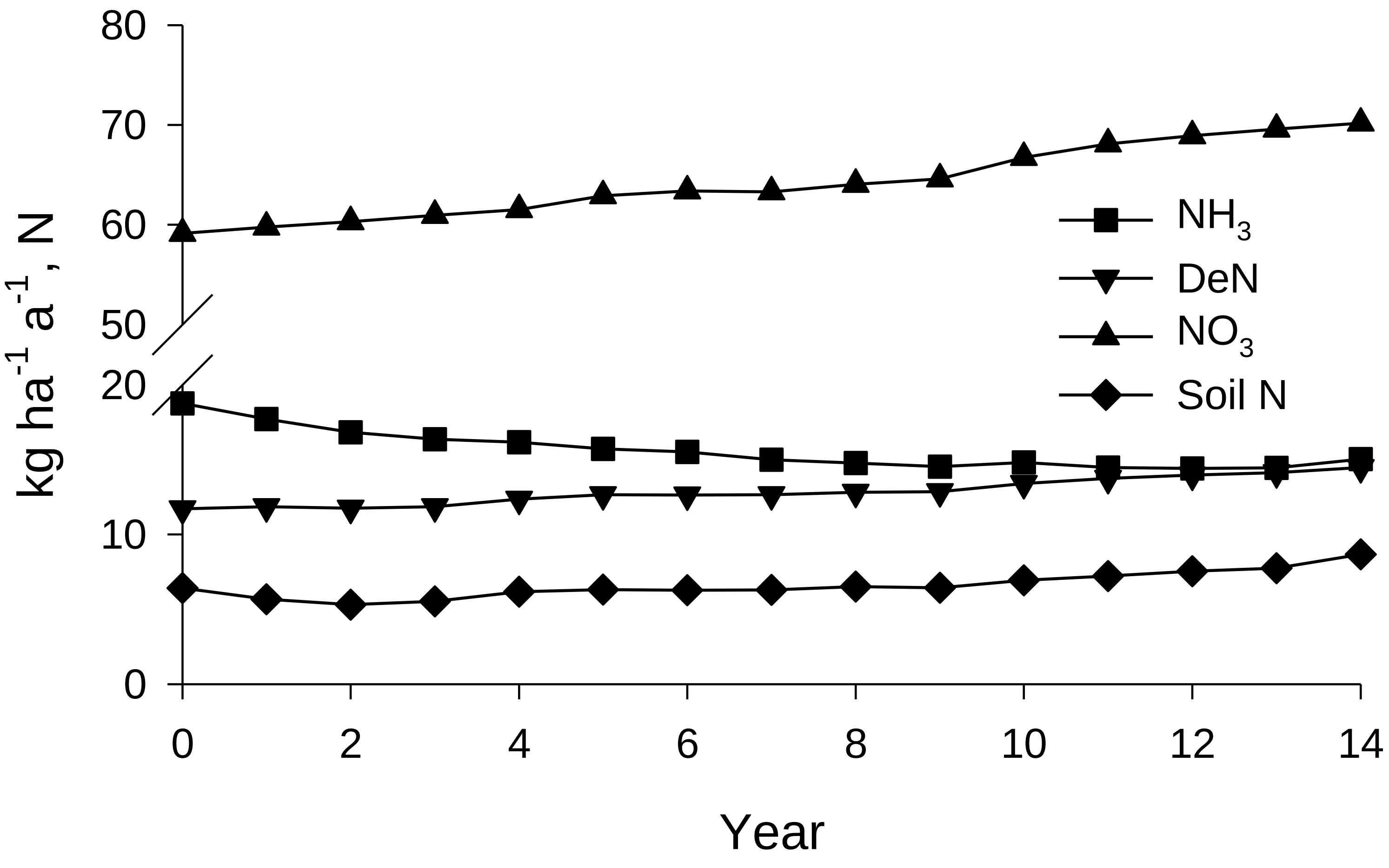
Effects of spatial hetero-geneity and potentials for collaboration?

Temporal heterogeneity example I



After Happe, Hutchings and Dalgaard (2010) Agricultural Systems 104(3)

Temporal heterogeneity example I



Source: Happe, Hutchings and Dalgaard (2010)

Temporal heterogeneity
example II: Pig farming in DK and DE

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		Bjerringbro, Denmark		Brandenburg, Germany	
Crop Rotation Unit	Field area (ha)	Fertilisation Organic (kg N ha^{-1})	Fertilisation Inorganic (kg N ha^{-1})	Fertilisation Organic (kg N ha^{-1})	Fertilisation Inorganic (kg N ha^{-1})
Set aside	42	0	0	0	0
Set aside	42	0	0	0	0
Winter wheat	42	150	54	150	72
Winter rape	42	150	59	150	77
Winter wheat	42	150	27	150	45
Winter wheat	42	150	54	150	72
Winter barley	42	118	63	118	79
Winter rye	42	102	45	102	58
Winter rape	42	150	59	150	77
Winter wheat	42	150	27	150	45
Winter wheat	42	150	54	150	72
Winter barley	42	118	63	118	79
Set aside	42	0	0	0	0
	546	58283	21009	58283	28378

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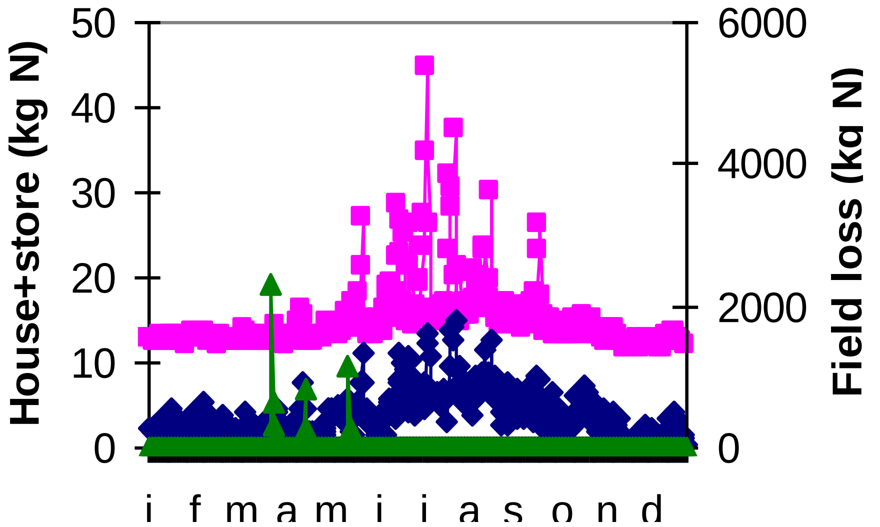
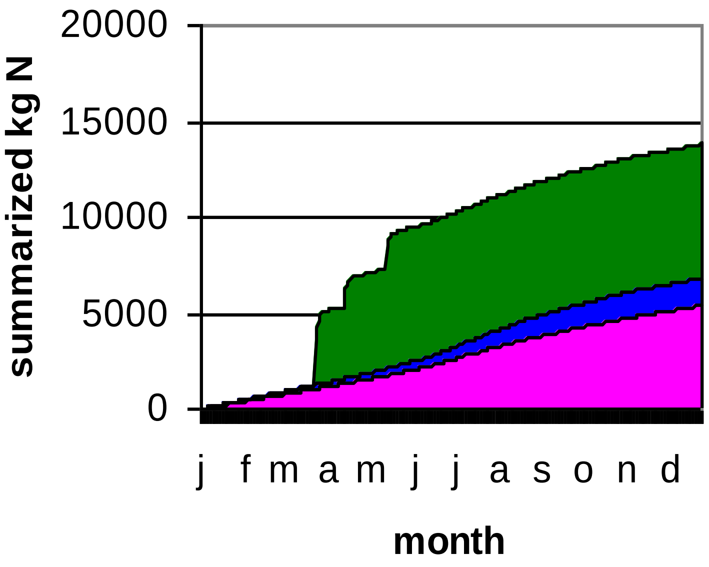
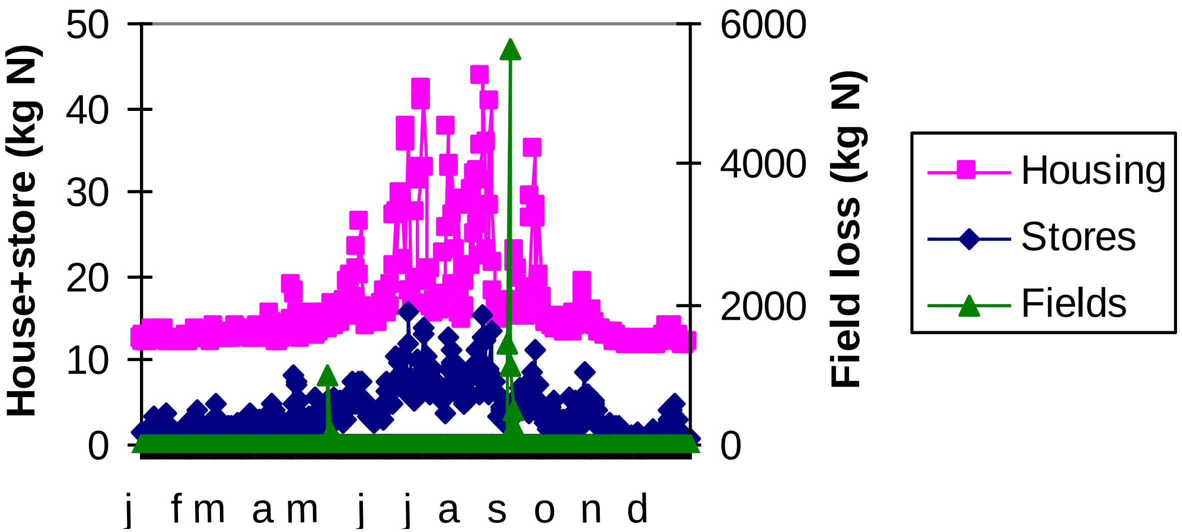
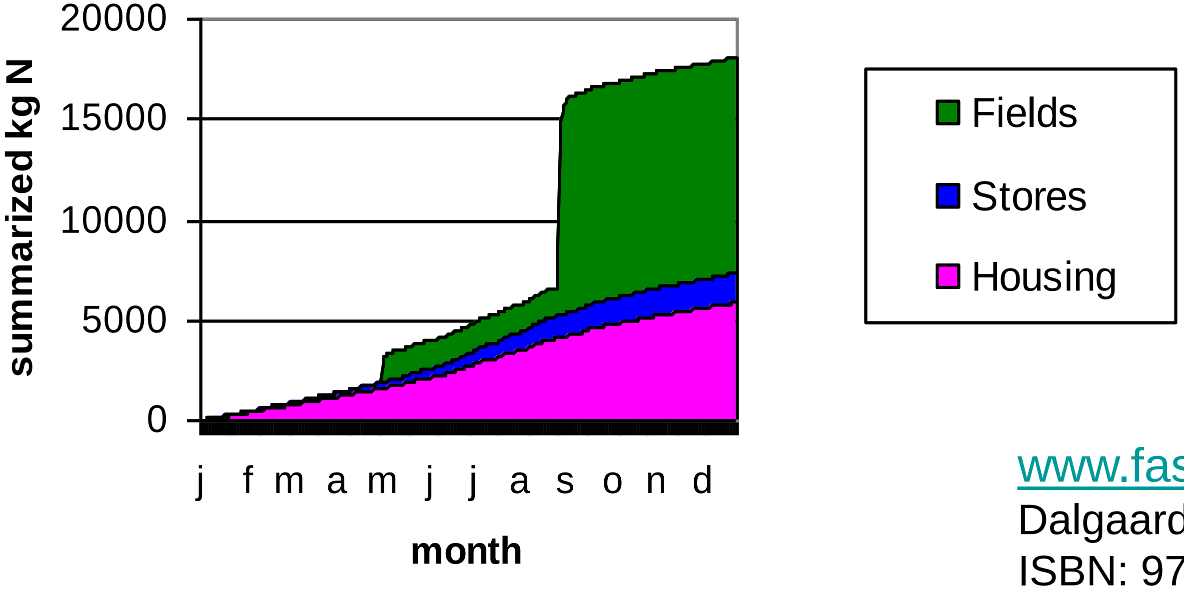
Pig Bacon - Viborg





Pig Bacon - Brandenburg



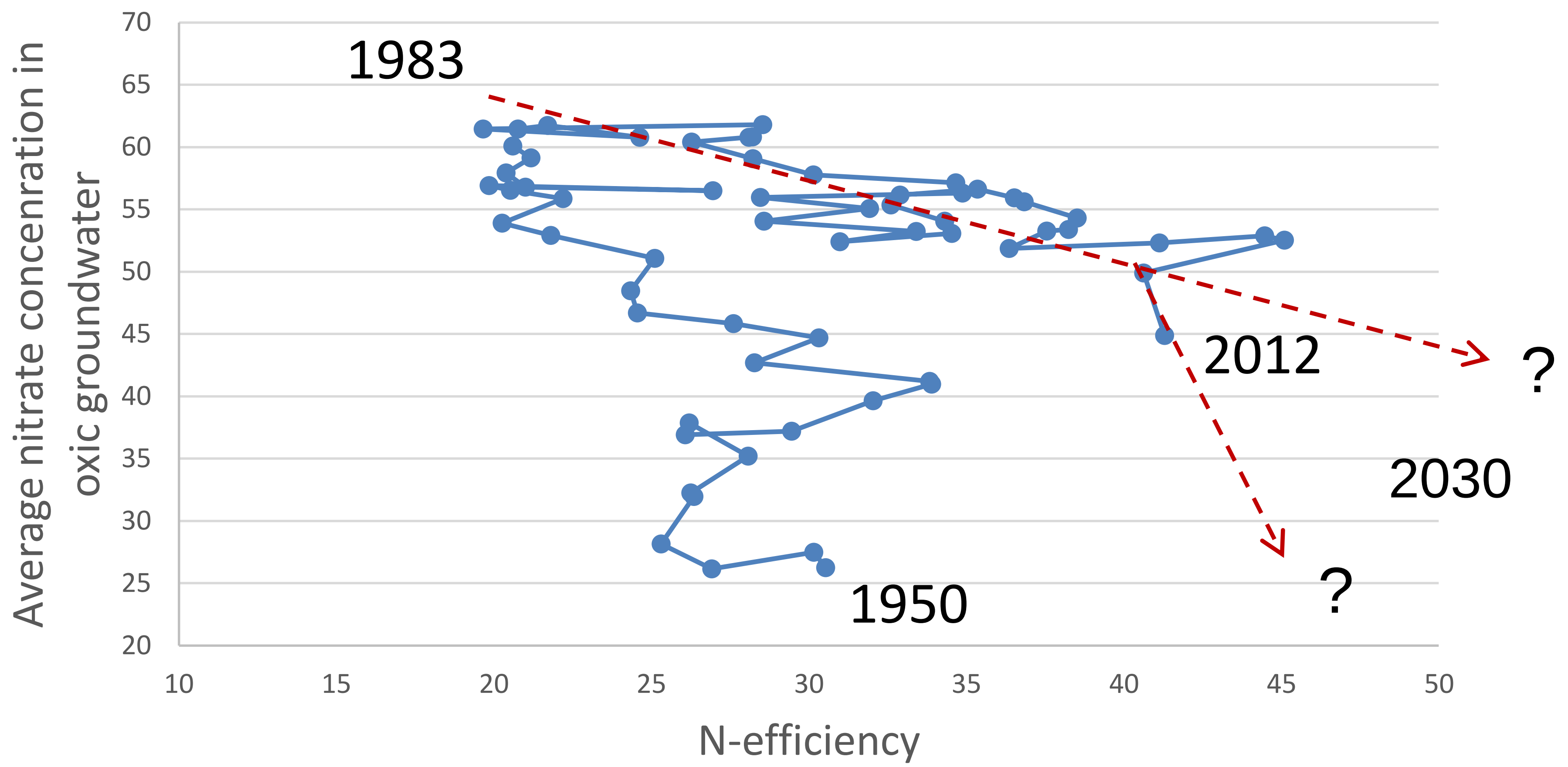


www.fasset.dk

Dalgaard et al. (2009)

ISBN: 978-88-9035-741-1.

Solution Scenarios



Hansen et al. (2017) Nature. Scientific Reports 7

Conclusions and perspectives

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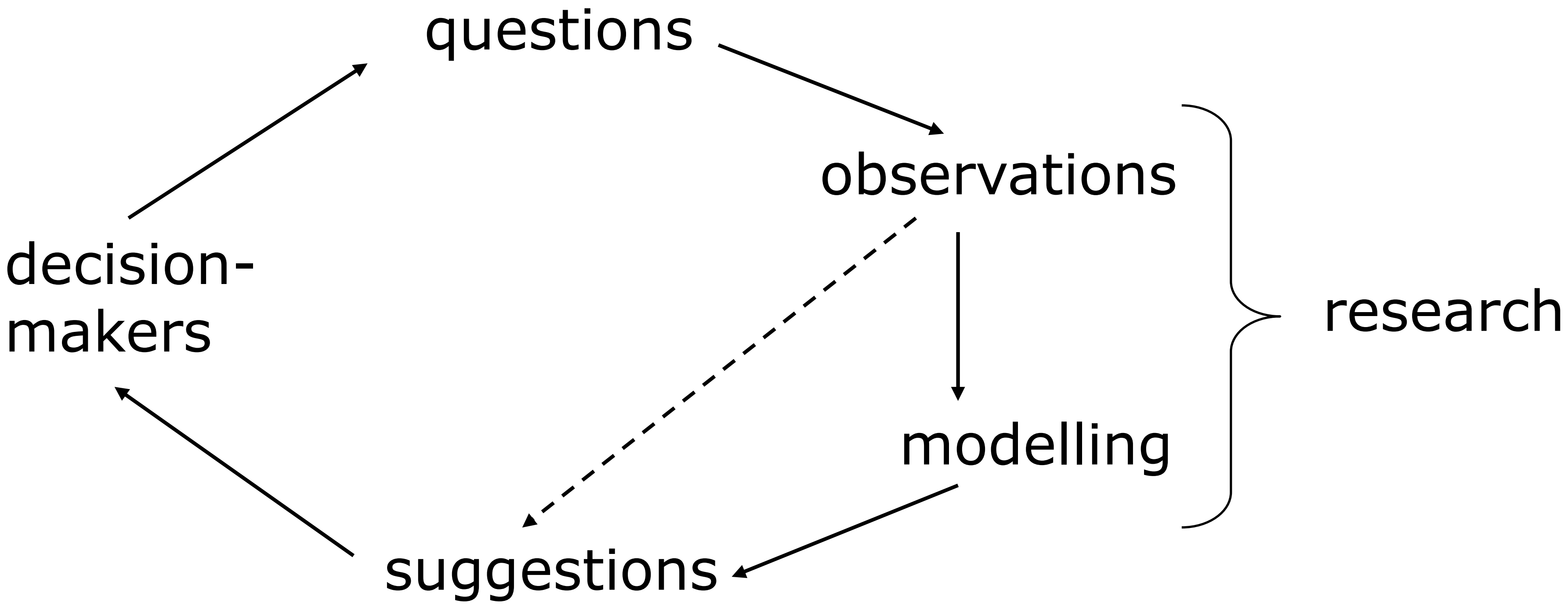
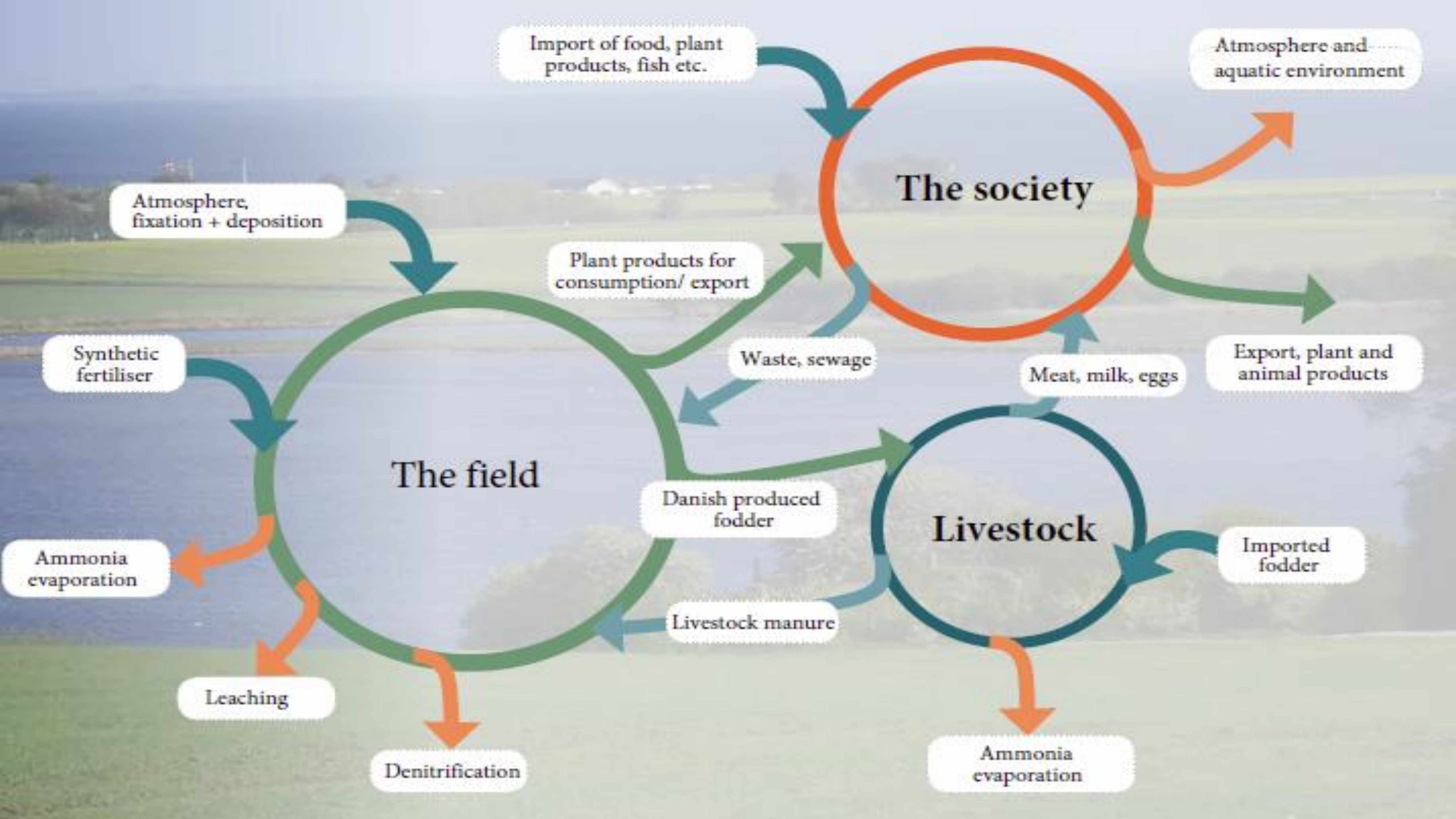
- **Landscape measures and management show great potentials; in particular for livestock farming!**
- **And can contribute to multiple objectives for the development of agricultural landscapes; i.e. increased N efficency, reduced losses, GHG mitigation, and tradeoffs for nature protection etc.**
- **Iterative multi-actor processes, integrated with further research and documentation is recommended to develop these opportunities**

The cycle of applied research

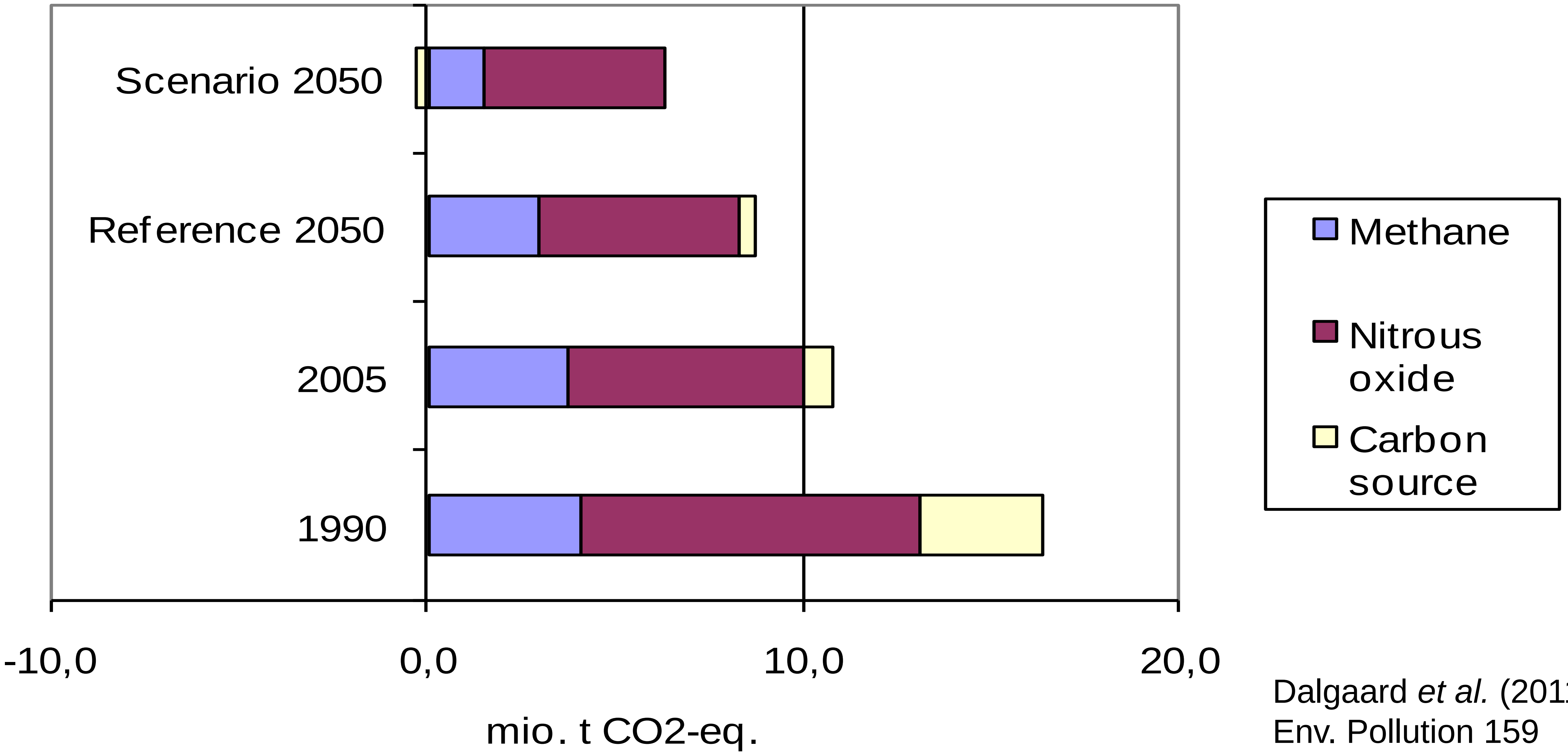


Adapted from Bierkens (2000)



Import of food, plant products, fish etc.
Atmosphere and aquatic environment
The society
Atmosphere, fixation + deposition
Plant products for consumption/ export
Synthetic fertiliser
Waste, sewage
Meat, milk, eggs
Export, plant and animal products
The field
Danish produced fodder
Livestock
Imported fodder
Ammonia evaporation
Livestock manure
Leaching
Denitrification
Ammonia evaporation

Greenhouse gas effects



Dalgaard *et al.* (2011)
Env. Pollution 159

Happy ending…

It is all about a balanced approach!

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