

The EU Nitrogen Expert Panel and its indicator for Nitrogen Use Efficiency (NUE)

Oene Oenema

Wageningen University

Background

EU Nitrogen Expert Panel



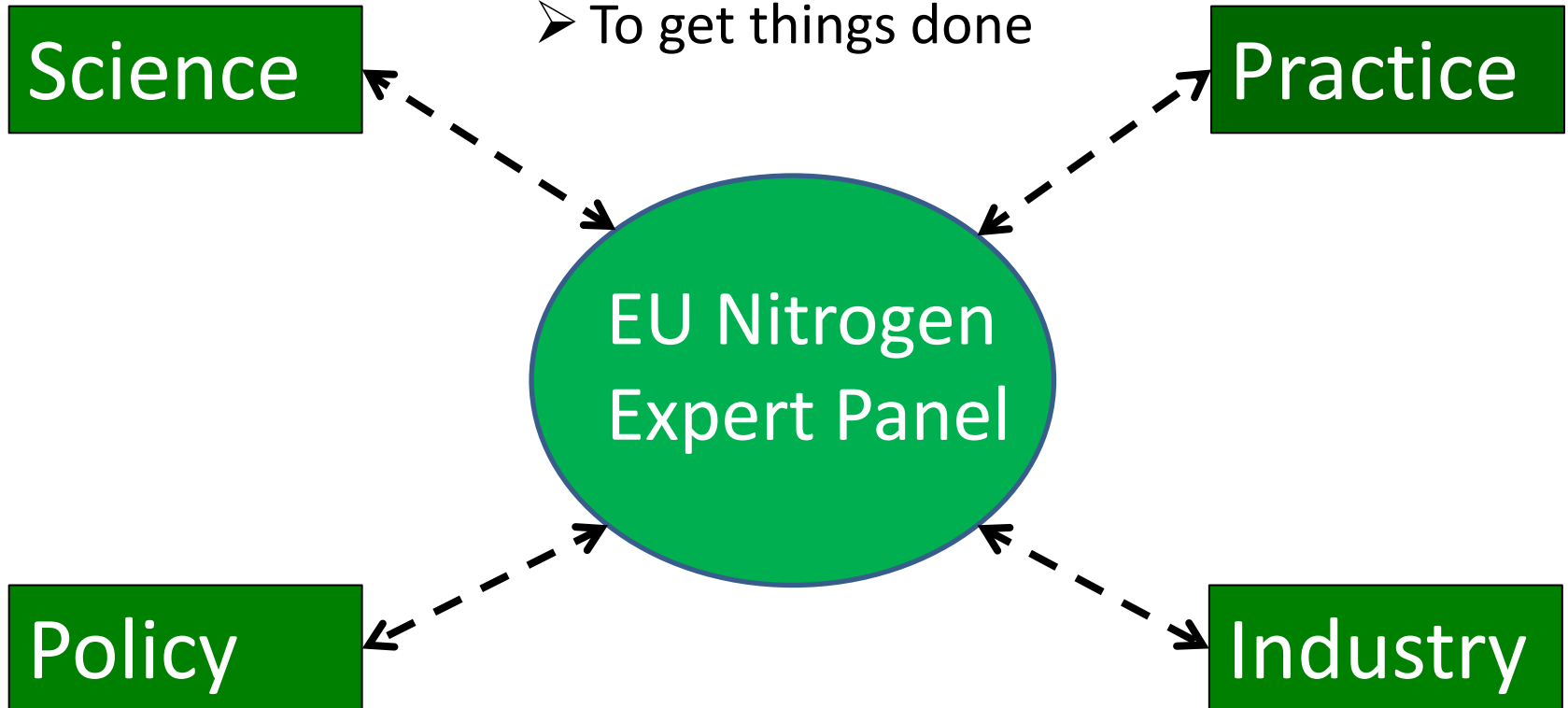
- 🌿 Nitrogen is essential for life
- 🌿 EU nitrogen experts have joined forces to promote efficient nitrogen use in food production
- 🌿 The ambition is to encourage best use of nitrogen to mitigate threats to our health and the environment





EU Nitrogen Expert Panel



- To improve linkages
- To get things done



EU Nitrogen Expert Panel

-  Objective is to contribute to improving NUE in food systems, through
 - i. communicating a vision and strategies on how to improve nitrogen use efficiency (NUE) in food systems
 - ii. generating new ideas, and recommending effective proposals and solutions
 - iii. acting as referee in controversial issues and by communicating as authority
- 

EU Nitrogen Expert Panel



- 🌱 Initiated by Fertilizers Europe
- 🌱 About 20 members
- 🌱 Joint meetings in Windsor, UK (Sept 2014) and Chantilly, France (June 2015)
- 🌱 Participation in other fora (GPNM, CFA, SDG, INMS, DG-Agri, IFA, etc.)



Why Nitrogen?



- 🌱 Nitrogen is a main crop yield limiting factor
- 🌱 Excess nitrogen has a range of unwanted effects to human health and the environment
- 🌱 Matching nitrogen demand and supply requires knowledge, tools and site-specific actions



Why nitrogen use efficiency?



- 🌱 Key indicator for '*resource use efficiency*' and '*sustainable intensification*'
- 🌱 Currently, there is no such indicator in use in policy and practice,
- 🌱 Easily understood by policy and practice

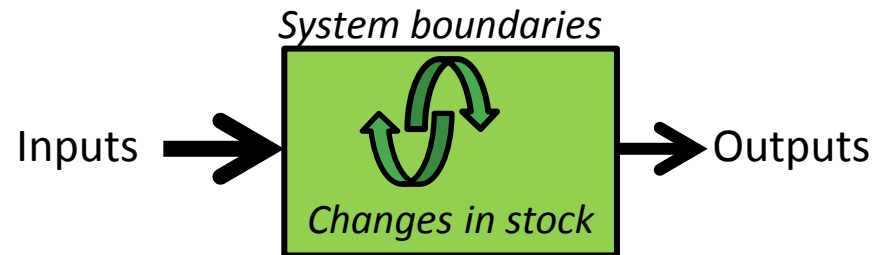


A NUE indicator

- 🌱 A robust and easy-to-use NUE indicator, based on the mass balance.
- 🌱 NUE should be reported together with nitrogen output and nitrogen surplus.

🌱 Hence:

- $NUE = Output / Input$
- $N\ output = N\ yield$
- $N\ surplus = Input - output$



Multi-scale applicable



- Concept is multi-scale applicable
 - Field, Farm, Region, Country, World
 - Food systems
 - Sectors
 - ...
- Systems and its boundaries have to be defined
- Time span has to be defined
- Changes in storage (e.g., soil) have to be reported



Interpretation

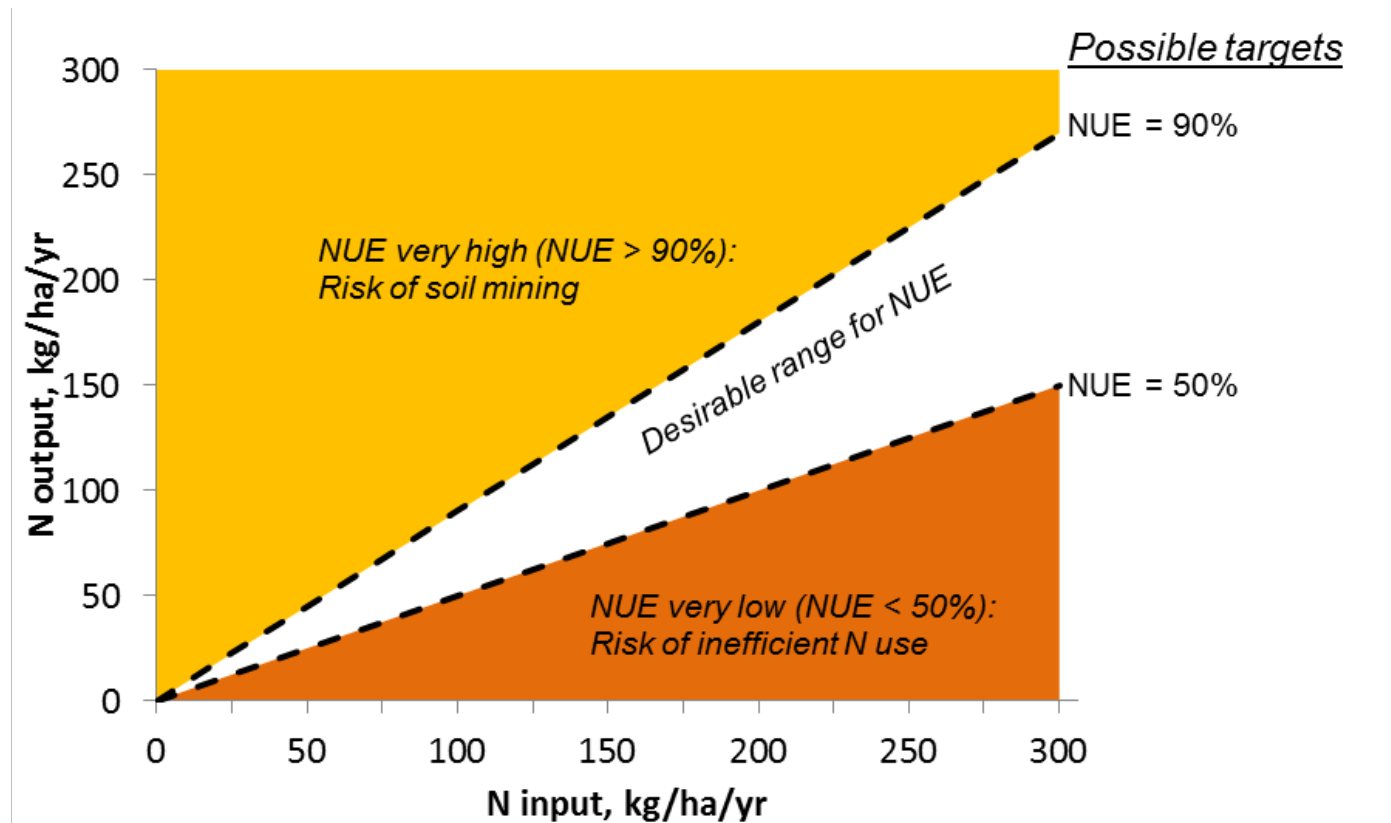


- 🌿 There are no absolute reference values for NUE, but possible target values can be derived.

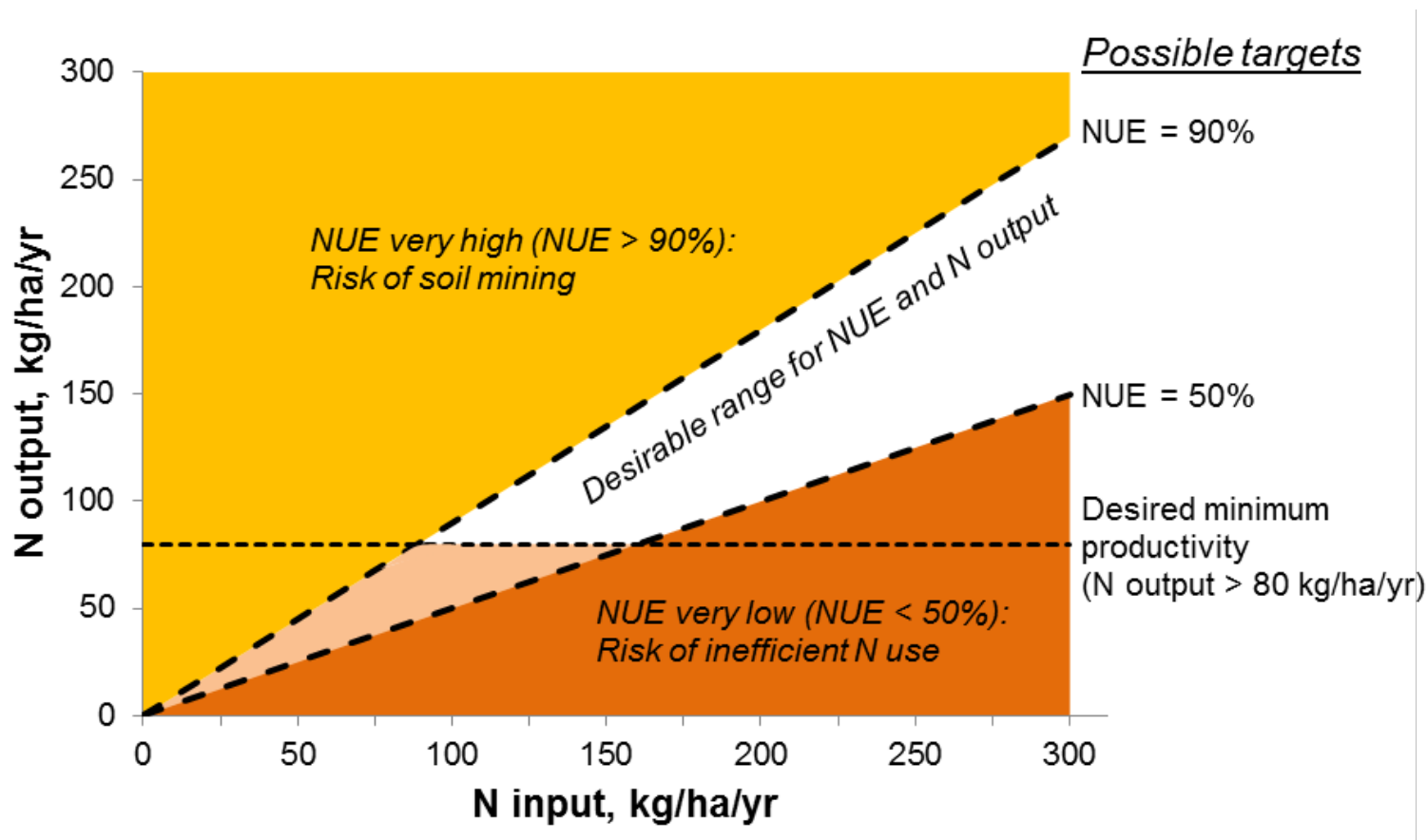
- 🌿 Interpretations can be made on the basis of:
 - Changes over time (direction and size of change)
 - Differences between
 - actual and target values (NUE gap)
 - different cropping systems
 - different management practices
 - different countries



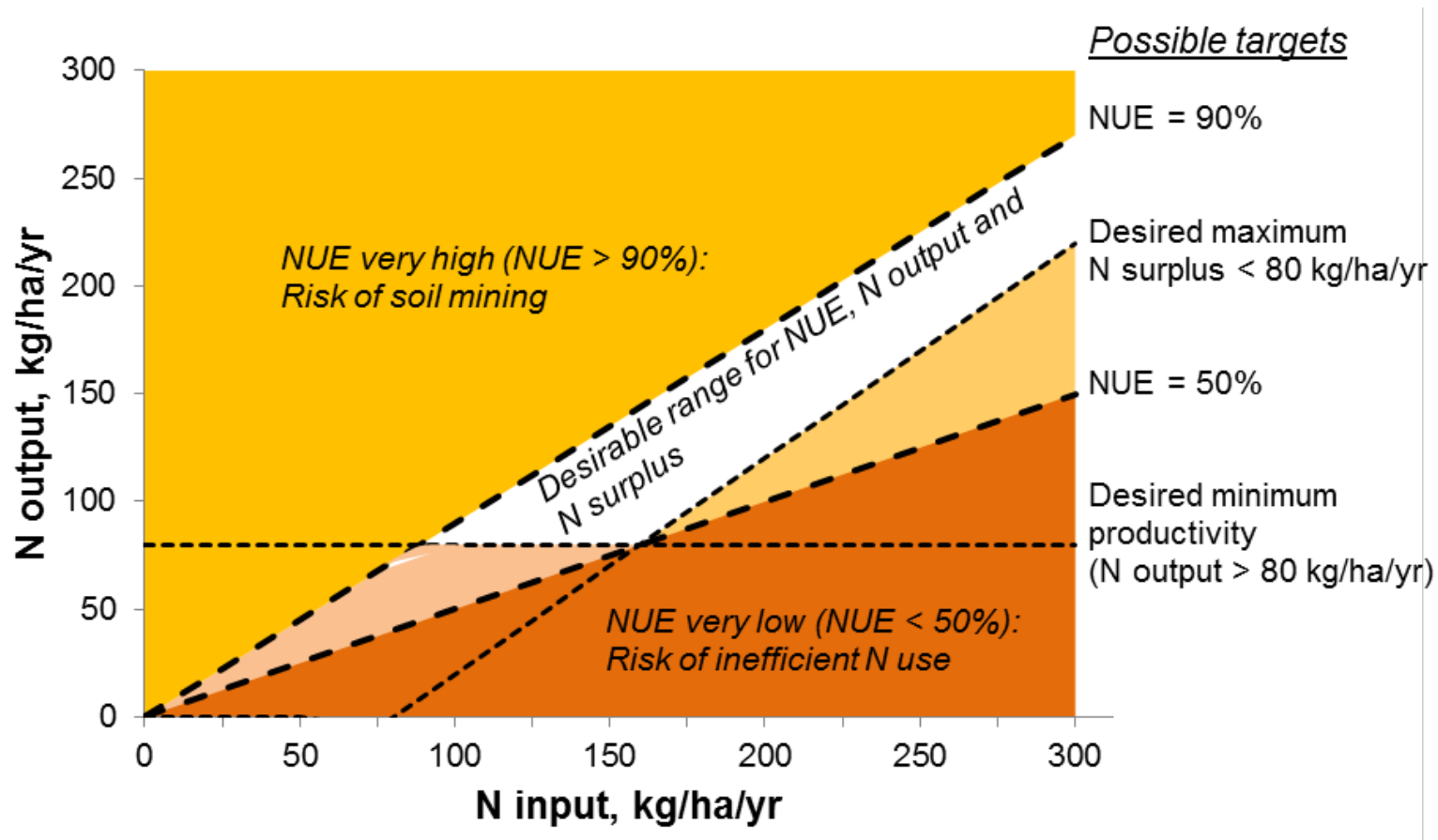
A graphical presentation, in three steps: (i) NUE



A graphical presentation, in three steps: (ii) N output



A graphical presentation, in three steps: (iii) N surplus



Applicability of concept:

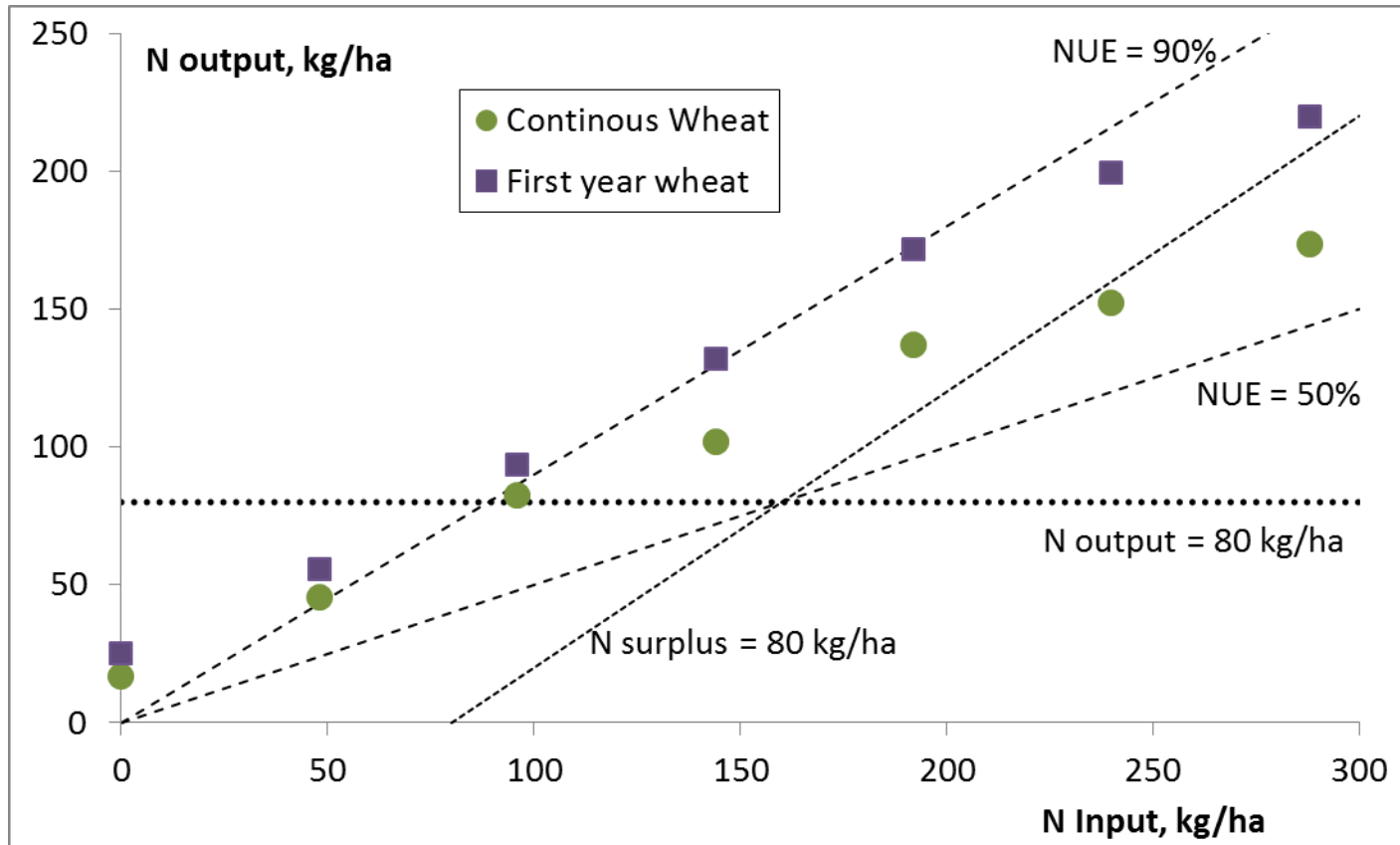


- 🌱 Nitrogen fertilization experiments
 - 🌱 Farming systems
 - 🌱 Cropping systems at regional/national levels
 - 🌱 Food chain systems
-
- 🌱 However, boundaries, inputs/outputs and target values change with change in systems!



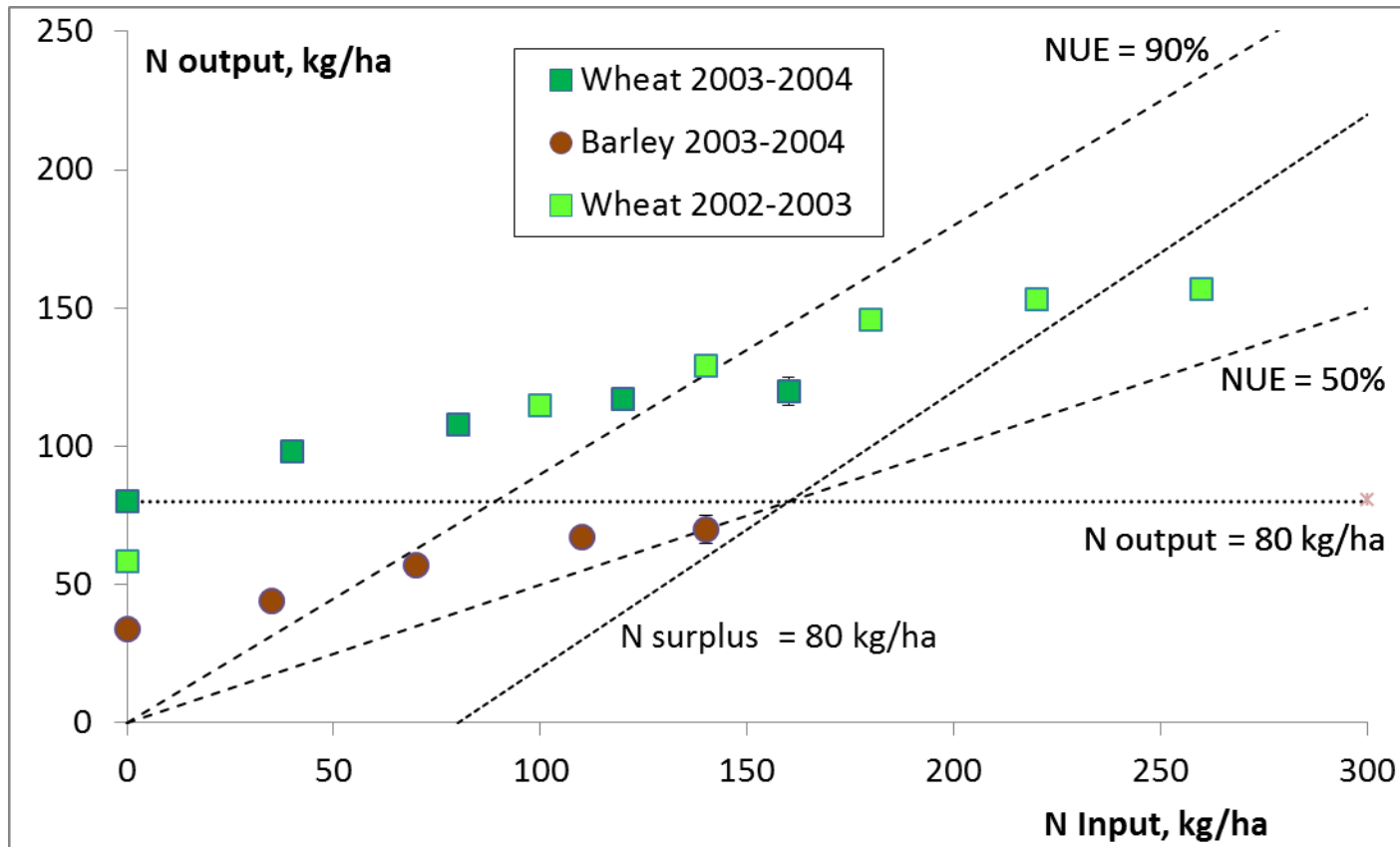
Long-term winter wheat

Broadbalk, Rothamsted, 1996-2012.



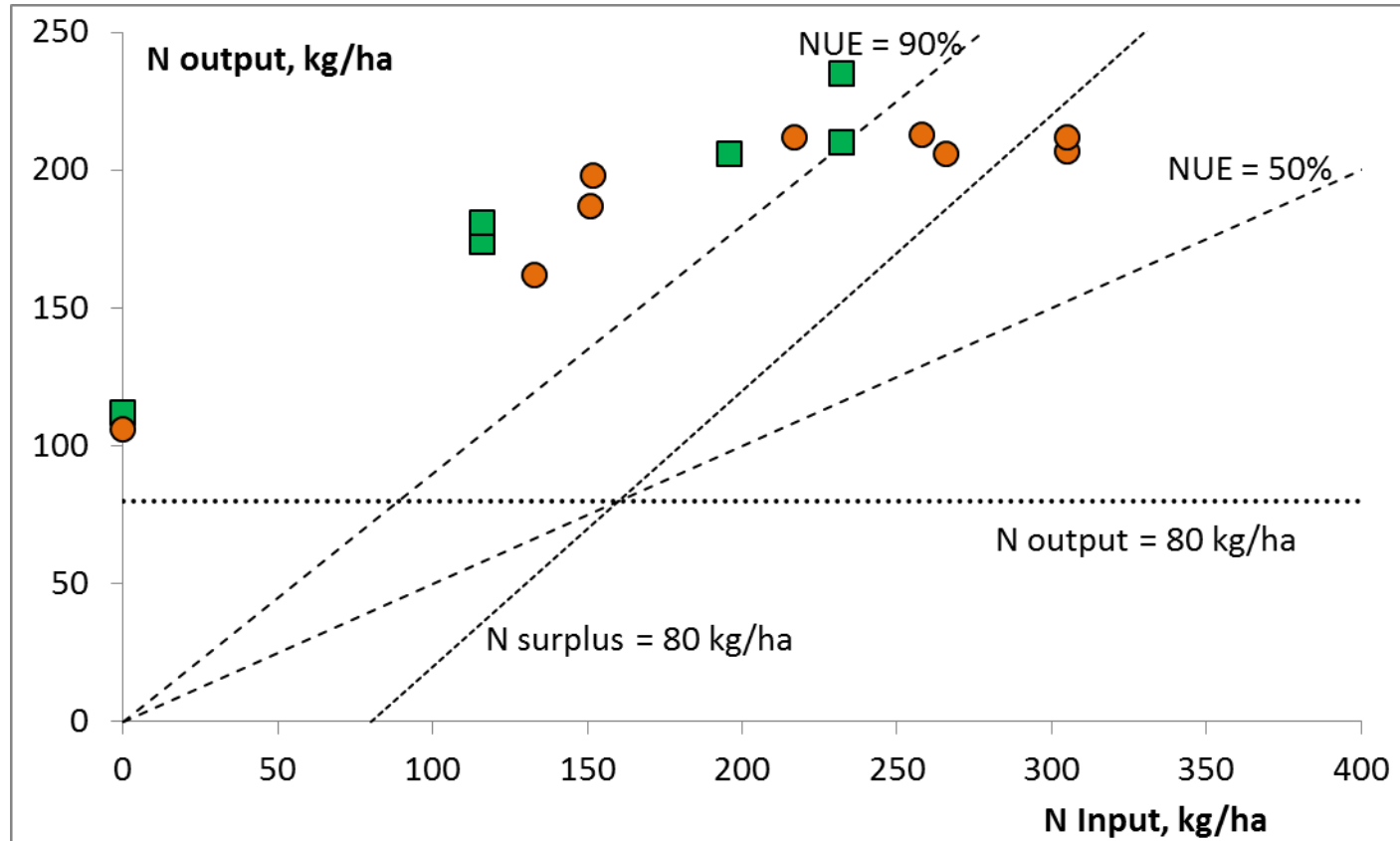
Macdonald et al (unpublished)
RA <http://www.rothamsted.ac.uk/era>

Annual winter wheat & barley Dryland, Spain, 2002-2003



Arregui et al (2006)
Arregui and Quemada (2008)

Annual potatoes, fertigated Netherlands, 1997-1998

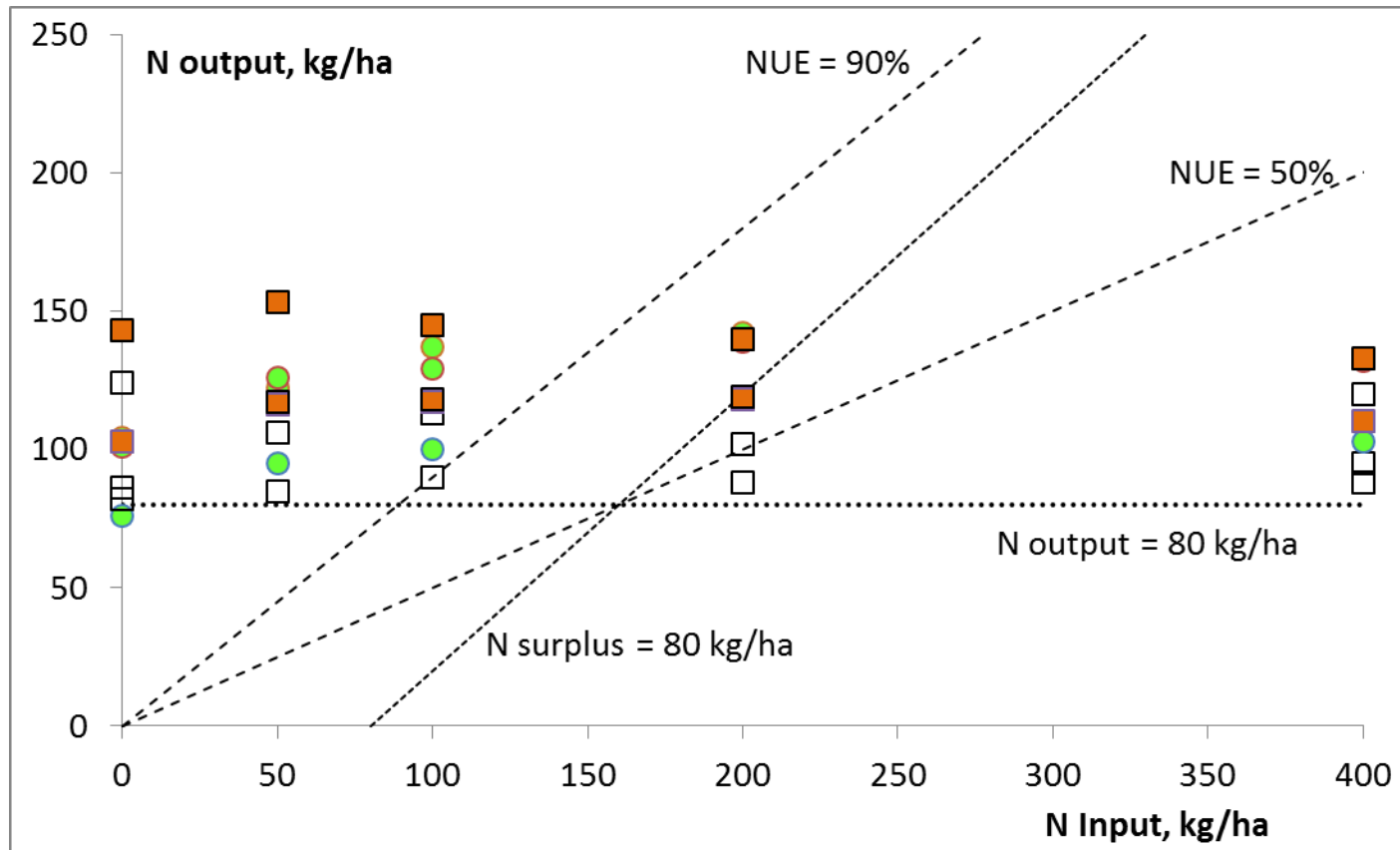


Tea leaves ('two and a bud')

Clonal & seedling trees, Kenya



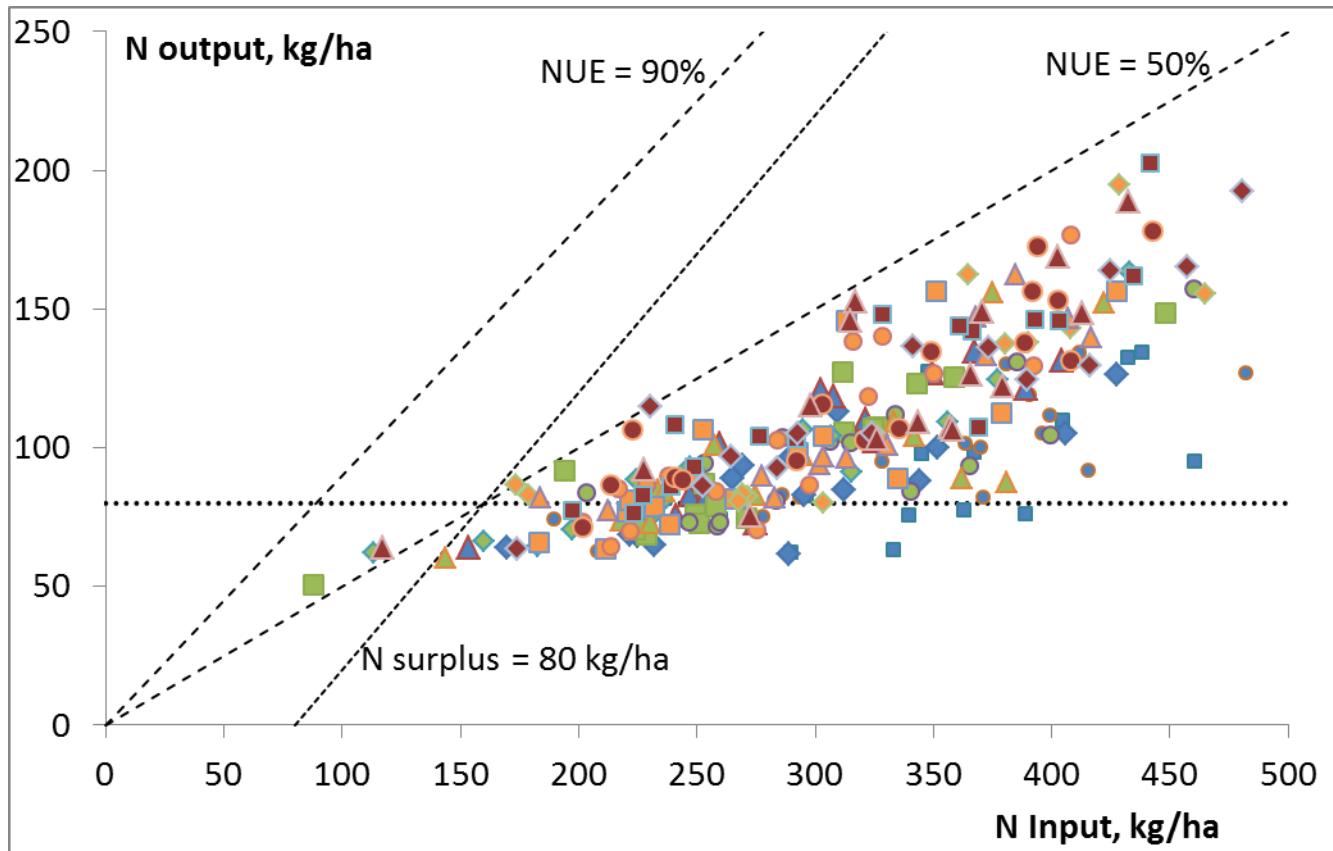
2002-2003



16 Dairy farms Netherlands, 1998-2013



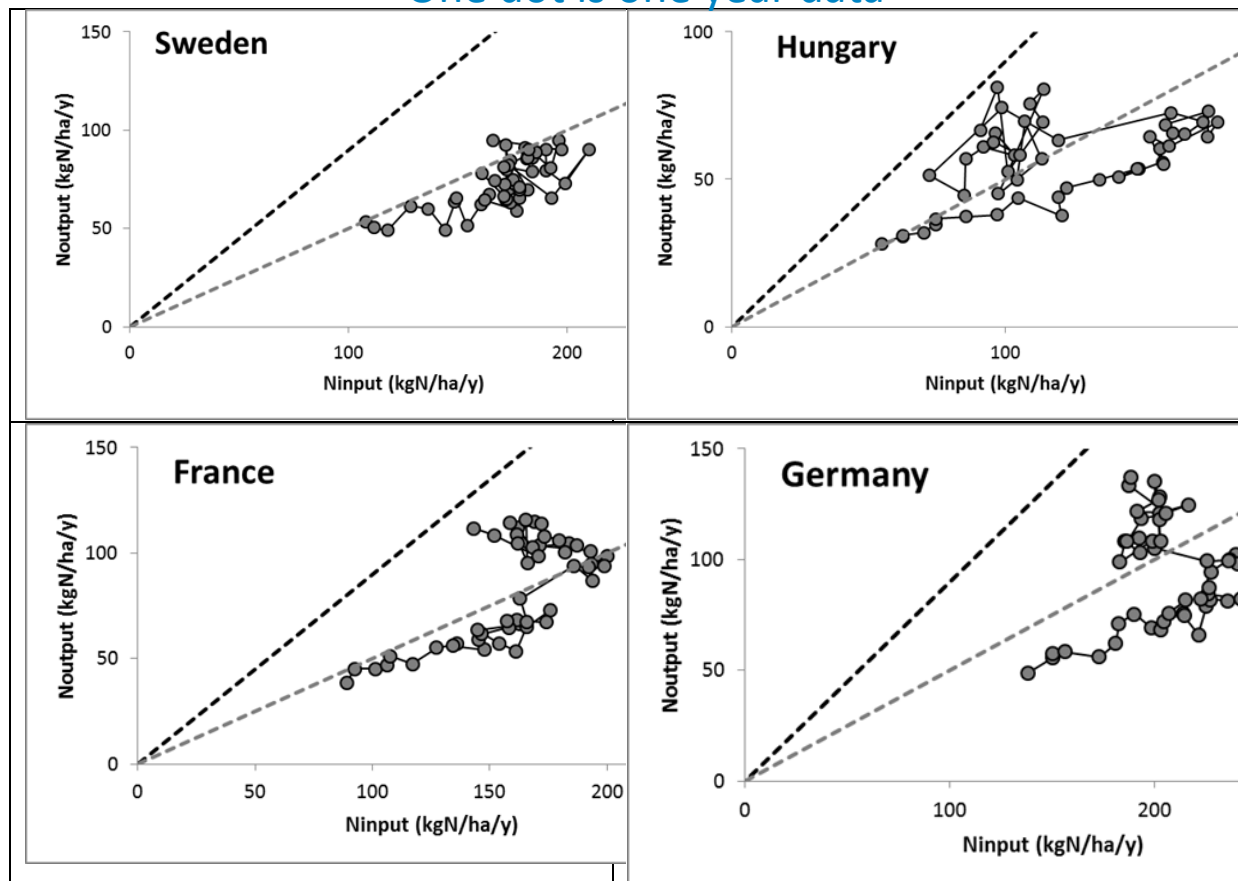
One dot is one farm; different symbols/colours mean different years



Oenema (2013)

Cropping systems Country level, 1991-2009

One dot is one year data



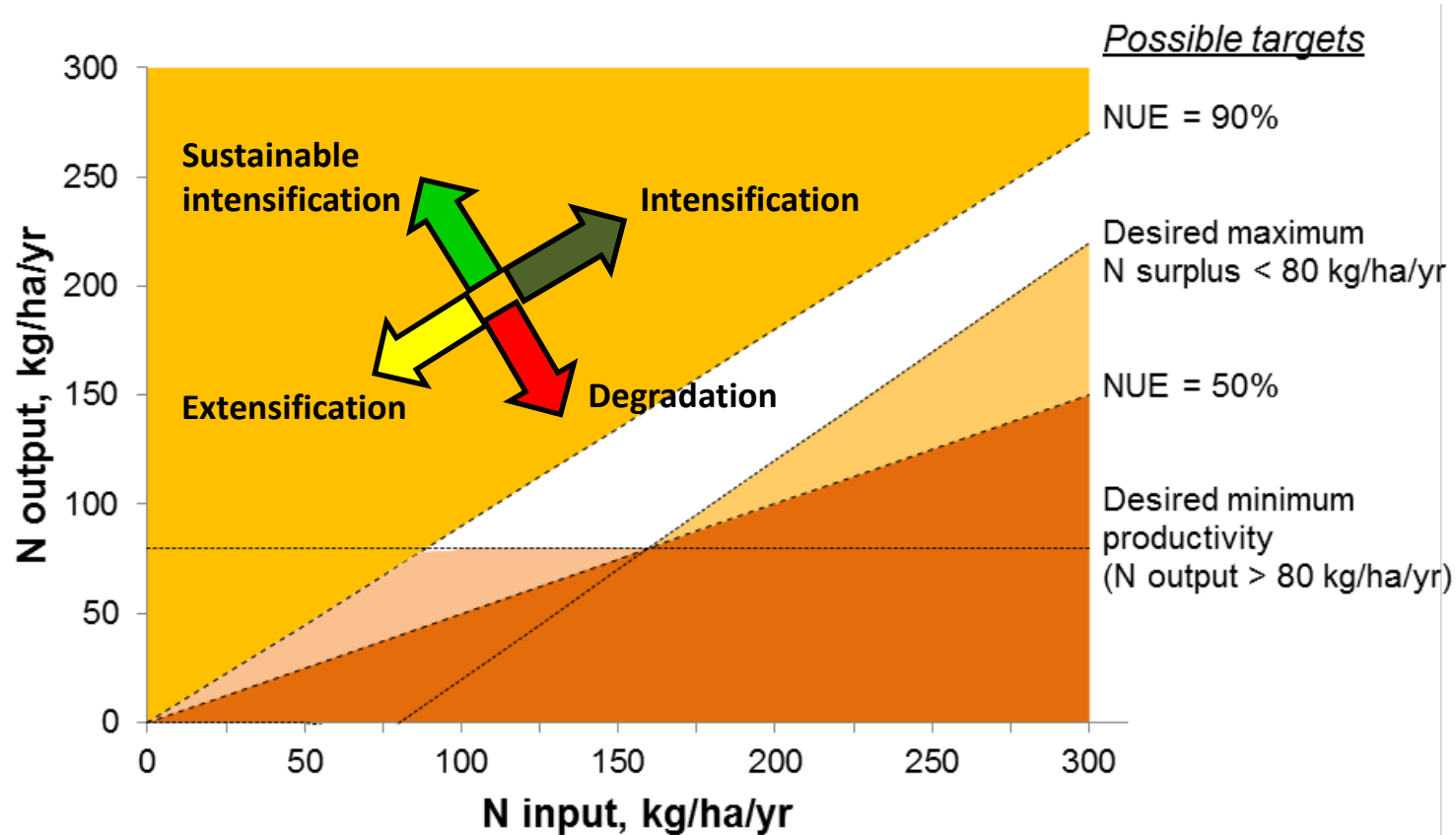
NUE in Global cropping systems



Crop	N input, Tg	N output, Tg	N surplus, Tg	NUE, %
Wheat	30	13	17	42
Maize	28	13	15	46
Rice	29	11	18	39
Soybean	20	16	4	80
Fruits & vegetables	25	3	21	14
Total	174	74	100	42

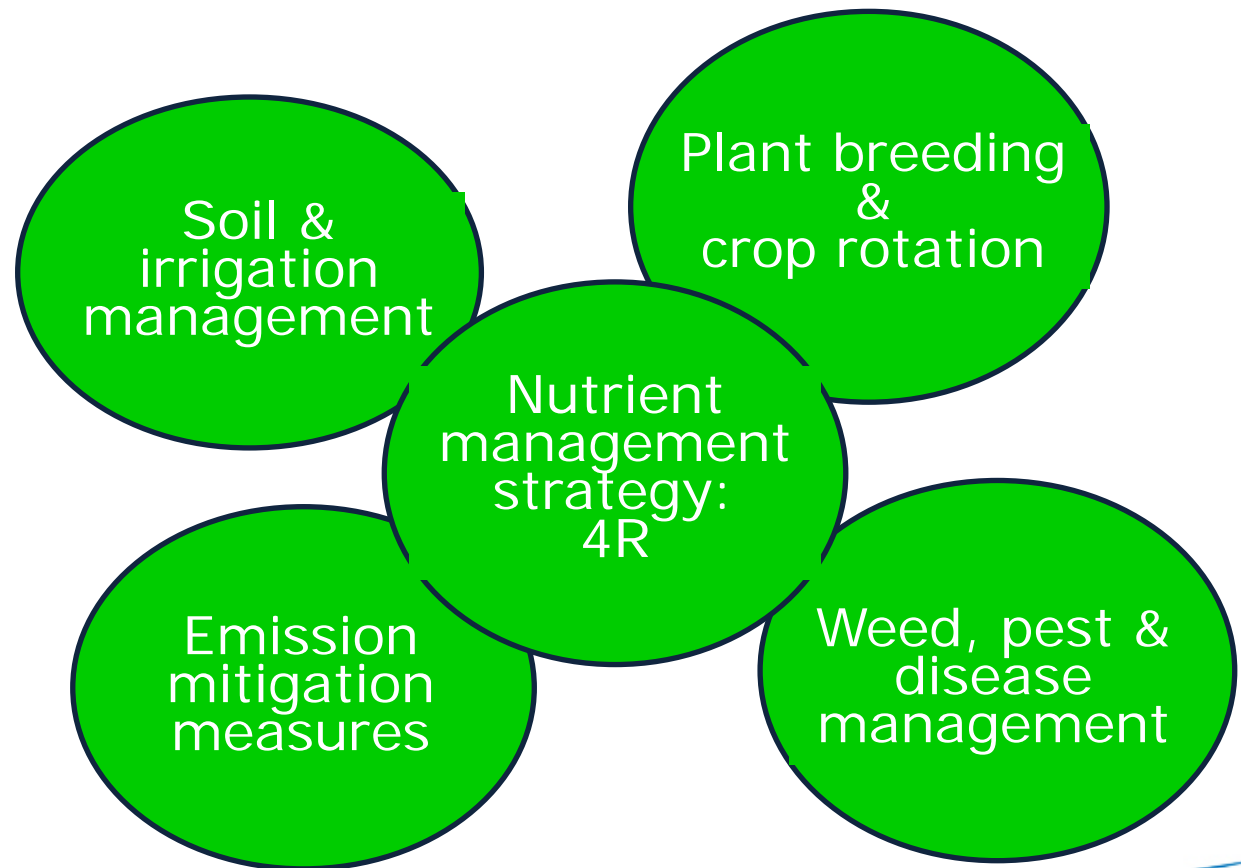
Zhang et al (2015)
Managing nitrogen for sustainable development.
Nature (in press)

Directions of change



Increasing NUE in crop production

→ Packages of measures



Increasing NUE in animal production

→ Packages of measures



Harmonized data collection- processing-reporting needed



Description of

- the system and its spatial and temporal boundaries;
- the nitrogen inputs into the system
 - Fertilizers, manures, composts, sludge, wastes
 - Biological N₂ fixation
 - Atmospheric deposition
- the nitrogen in harvested outputs
 - Crop production
 - Animal products
- the changes in storage (e.g., soil)



Important data sources in EU



- 🌿 Farm Accountancy Data Network (FADN, 1/yr).
- 🌿 Farm structure survey (FFS, 1/3 yrs)
- 🌿 Survey on Agricultural Production Methods (SAPM, once in 5-10 yrs)

- 🌿 Additional surveys
 - Industry
 - Member States



Communication important



- 🌱 Communication of the design and objectives;
- 🌱 Communication about “Who is doing what?”
- 🌱 Involvement of farmers needed; provide information back to farmers (Benchmarking)



Summary



- ❧ NUE is key indicator for '*resource use efficiency*' and for '*sustainable intensification*'
- ❧ NUE, N_{surplus} & N_{yield} reported together
- ❧ NUE is system specific;
- ❧ Supply of N by soil important (residual N)
- ❧ Need for a harmonized data collection – processing – reporting chain, using protocols and uniform formats

Thanks for your attention



EU Nitrogen Expert Panel

Wageningen University, Alterra,
PO Box 47, NL-6700 Wageningen

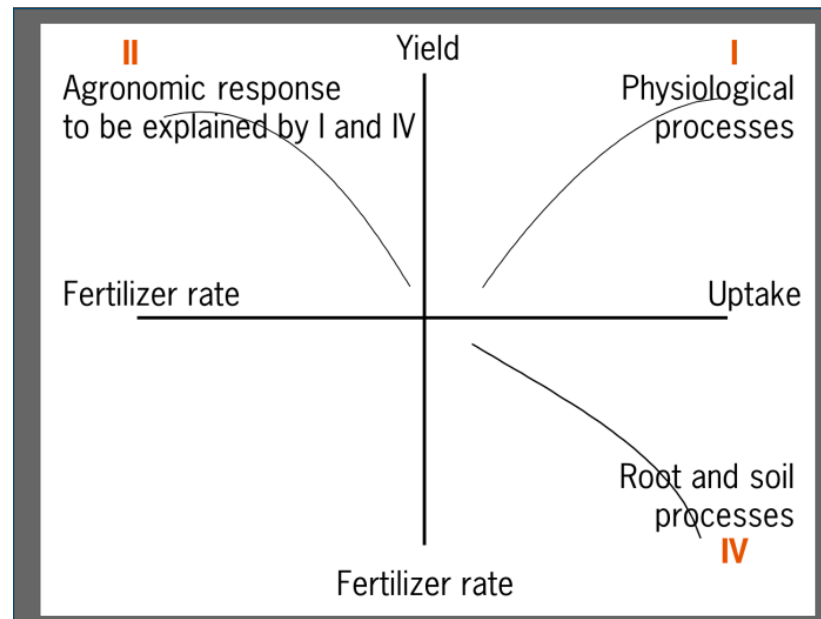
Email: oene.oenema@wur.nl

Website: [www\eunep.com](http://www.eunep.com)



NUE indicators in use

- **RE** = apparent recovery efficiency of applied nutrient
- **PE** = Physiological efficiency of applied nutrient
- **IE** = Internal utilization efficiency of nutrient
- **AE** = Agronomic efficiency of applied nutrient
- **PFP** = Partial factor productivity of applied nutrient



Dobermann, 2008

Building-block principle

Eurostat



- 🌿 There is a common need for data → potential for harmonization of data collection
- 🌿 Approach → unravel the needs for data and coefficients for all reporting requirements
- 🌿 Quality control



Six building blocks



- Inputs
 - Nutrients, pesticides, water, energy
- Land use & climate
- Crop production
- Livestock production
- Management
 - Livestock
 - Farm
- Soil, water and air quality

Inputs

**Land
use/nature/climate**

Crop production

Livestock

Management

**Soil and water
quality**



Eurostat 28 AEs



First priority AEs	DPSIR	Second priority AEs	DPSIR
AEI 5 Mineral fertiliser consumption	D	AEI 1 Agri-env commitment	R
AEI 6 Consumption of pesticides	D	AEI 2 Agricultural areas under Natura 2000	R
AEI 7 Irrigation	D	AEI 3 Farmers' training level	R
AEI 8 Energy use	D	AEI 4 Area under organic farming	R
AEI 11.1 Soil cover	D	AEI 9 Land use change	D
AEI 11.2 Tillage practices	D	AEI 10.1 Cropping patterns	D
AEI 11.3 Manure storage	D	AEI 10.2 Livestock patterns	D
AEI 12 Intensification/extensification	D	AEI 13 Specialisation	D
AEI 15 Gross nitrogen balance	P	AEI 14 Risk of land abandonment	D
AEI 16 Risk of pollution by phosphorus	P	AEI 17 Pesticide risk	P
AEI 18 Ammonia emissions	P	AEI 20 Water abstraction	P
AEI 19 Greenhouse gas emissions	P	AEI 21 Soil erosion	P
AEI 26 Soil quality	S	AEI 22 Genetic diversity	P
		AEI 23 High Nature Value farmland	P
		AEI 24 Renewable energy	P
		AEI 25 Farmland birds	S
		AEI 27.1 Water quality – Nitrate	S
		AEI 27.2 Water quality – Pesticide	S
		AEI 28 Landscape - State and diversity	S



DireDate project



- 🌱 Analysis of policy reporting requirements
- 🌱 Analysis of the data needs of the 28 agri-environmental indicators in EU;
- 🌱 Analysis of the data collection – data processing – reporting chains in MSs
- 🌱 Developing recommendations and proposals for harmonisation



Reports



Website Eurostat about AEI

http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/introduction

Summary report DireDate:

http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-11-005



Underlying reports DireDate:

 http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators/publications



Scales data collection

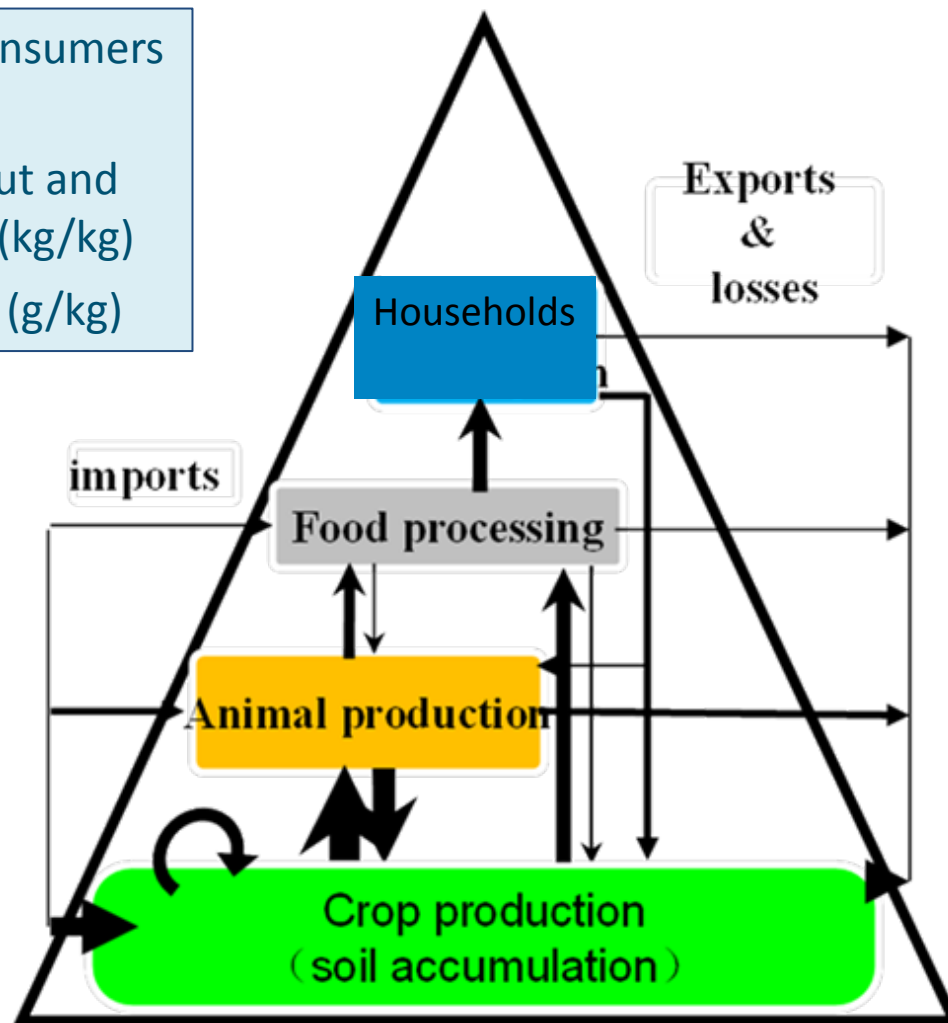


	Spatial scales				
Temporal Scale ▼	Farm	Catchment	NUTS 3	NUTS 2	NUTS 1
Monthly		Water quality data			
Annual	Crop areas & yield, Livestock numbers, Farm inputs, Management (soil, crop, livestock)		Wild life counts		
3-5 years	Machines, Housings/buildings, Conversion factors Organic farming	Erosion	Land cover, Natural habitats,		
5-10 years	Farm structure, Training	Soil data, Climate data, Landscape		Non- agricultural areas	



NUE in the food chain

- **NUE_f** = ratio of total N in food of consumers and total N input (%)
- **N cost of food** = ratio of total N input and total N in food of consumers (kg/kg)
- **N footprint** = N surplus per kg food (g/kg)



NUE at farm scale



Two main options:

- Farm gate balance
- Gross nitrogen balance
(Soil surface balance)

