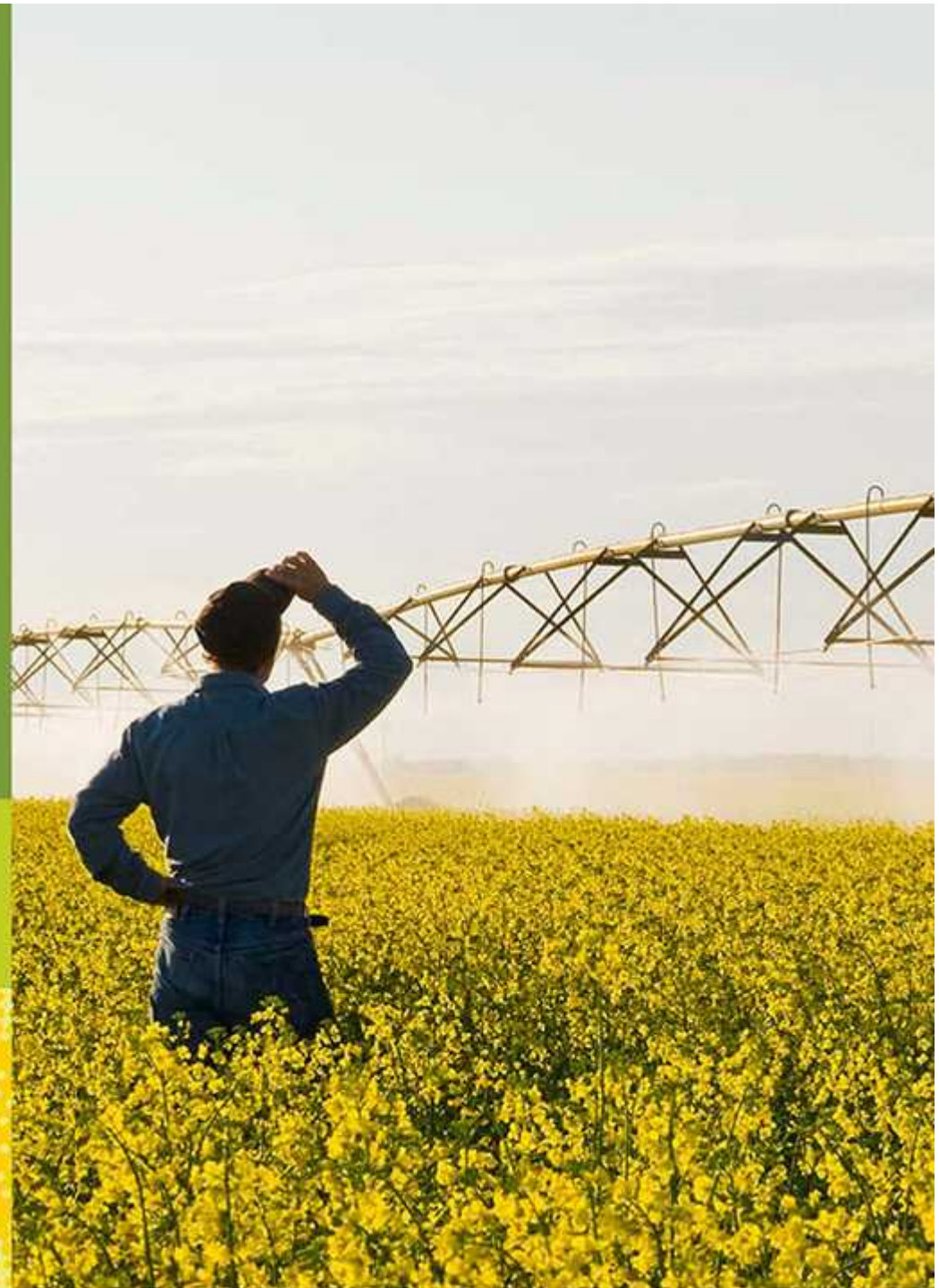




Knowledge grows

## NUE, N balance, and N yield – a combined indicator system to evaluate N use in crop production systems

Frank Brentrup & Joachim Lammel, Yara Int.  
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# Content

- Introduction to Nitrogen Use Efficiency (NUE)
- A novel NUE indicator system developed by the EU Nitrogen Expert Panel
- Application of the new concept
- Summary

# Definition of Nitrogen Use Efficiency (NUE) and methods to derive NUE

NUE quantifies how much of the available N is actually utilized by an agricultural system.

- Use of labeled N to trace the fate of applied N
  - Precise, but expensive method that is only applicable in scientific experiments at field scale and for a limited period of time
- “Difference method”
  - $(N \text{ crop uptake fertilized} - N \text{ crop uptake unfertilized}) / N \text{ fertilizer input}$
  - A “zero N” plot is only available in field trials (field scale)
  - Only valid for long-term field trials
- **NUE = N output / N input**
  - easy-to-use indicator not only for scientists but also for practice and policy
  - data usually available from farms and statistics
  - applicable at different scales (crop/rotation, farm, region/country) and over time
  - to be interpreted in relation to productivity (N output) and N losses to the environment ( $N \text{ surplus} = N \text{ input} - N \text{ output}$ )

# The European Nitrogen Expert Panel



Established spring 2014 based on an initiative of Fertilizers Europe  
Consists of about 20 members from science, policy, practice and industry

## General mandate

- to contribute to improving the nitrogen use efficiency in food systems in Europe, through
  - communicating about NUE in food systems in Europe
  - generating new ideas, and recommending effective proposals and solutions
  - acting as referee in controversial issues about nitrogen and communicating as authority
- First mandate of the EU Nitrogen Expert Panel:
  - To prepare a well elaborated proposal for assessing NUE in EU, to be used as indicator by policy and practice.

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

# Nitrogen Use Efficiency (NUE)

- an indicator for the utilization of nitrogen in agriculture and food systems

Prepared by  
EU Nitrogen Expert Panel

Oenema O, Brentrup F, Lammel J, Bascou P, Billen G, Dobermann A, Erismann JW, Garnett T, Hammel M, Haniotis T, Hillier J, Hoxha A, Jensen LS, Oleszek W, Pallière C, Powlson D, Quemada M, Schulman M, Sutton MA, Van Grinsven HJM, Winiwarter W.



## Recommended citation:

EU Nitrogen Expert Panel (2015) *Nitrogen Use Efficiency (NUE) - an indicator for the utilization of nitrogen in agriculture and food systems*. Wageningen University, Alterra, PO Box 47, NL-6700 Wageningen, Netherlands.

## N input and N output data provide multiple information about sustainability of agricultural production systems

- $N \text{ output} / N \text{ input} * 100 = \text{NUE (\%)} \quad \rightarrow \text{Resource use efficiency (society)}$
- $N \text{ output (kg N/ha)} \quad \rightarrow \text{Productivity (economy)}$
- $N \text{ input} - N \text{ output} = N \text{ surplus (kg N/ha)} \quad \rightarrow \text{Potential N loss (environment)}$

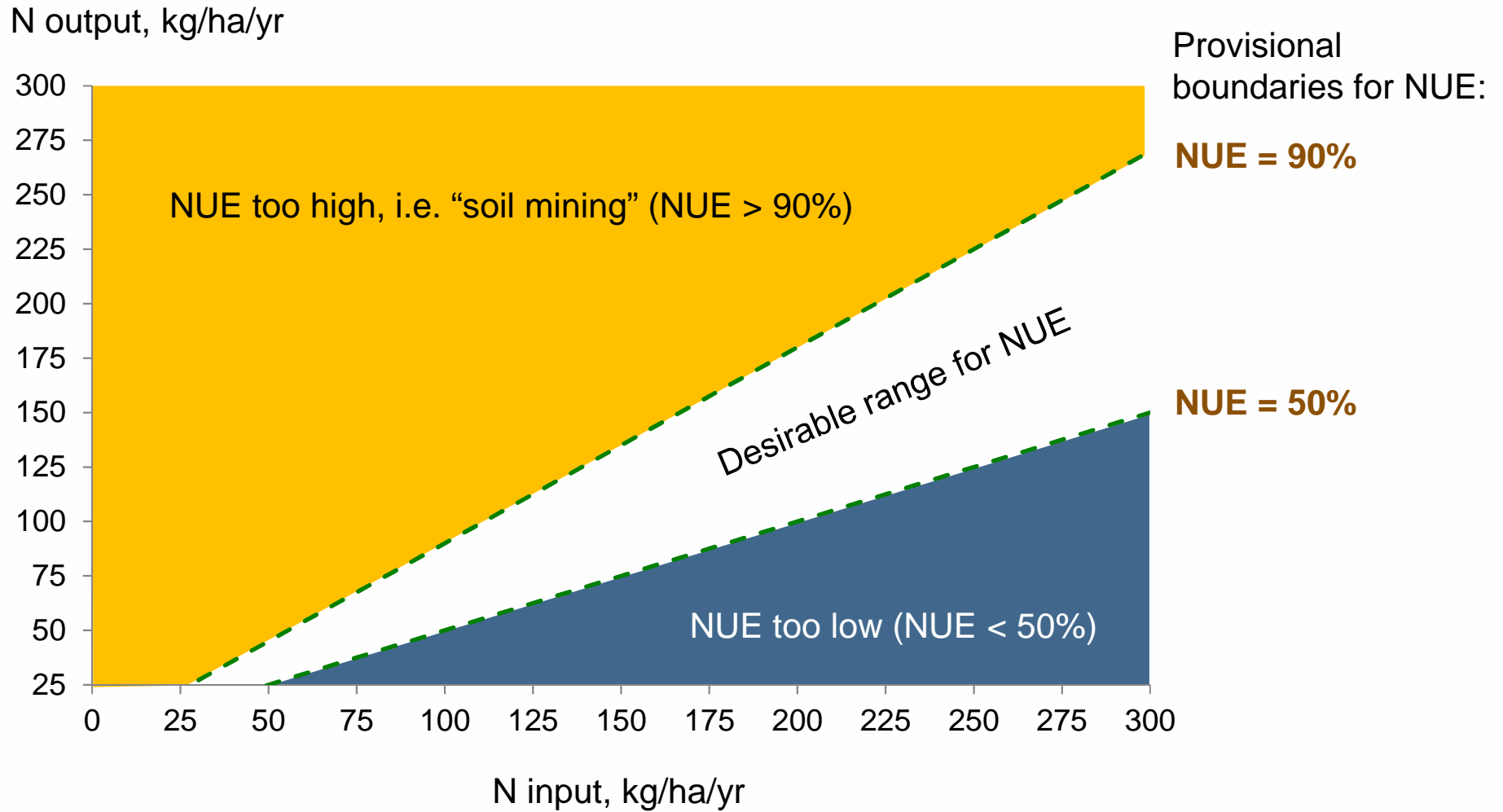
### The approach of the EU N Expert Panel:

All three indicators are combined into a two-dimensional input – output diagram that allows system performance to be assessed in relation to all three dimensions.

# Input and output items considered for the NUE indicator system

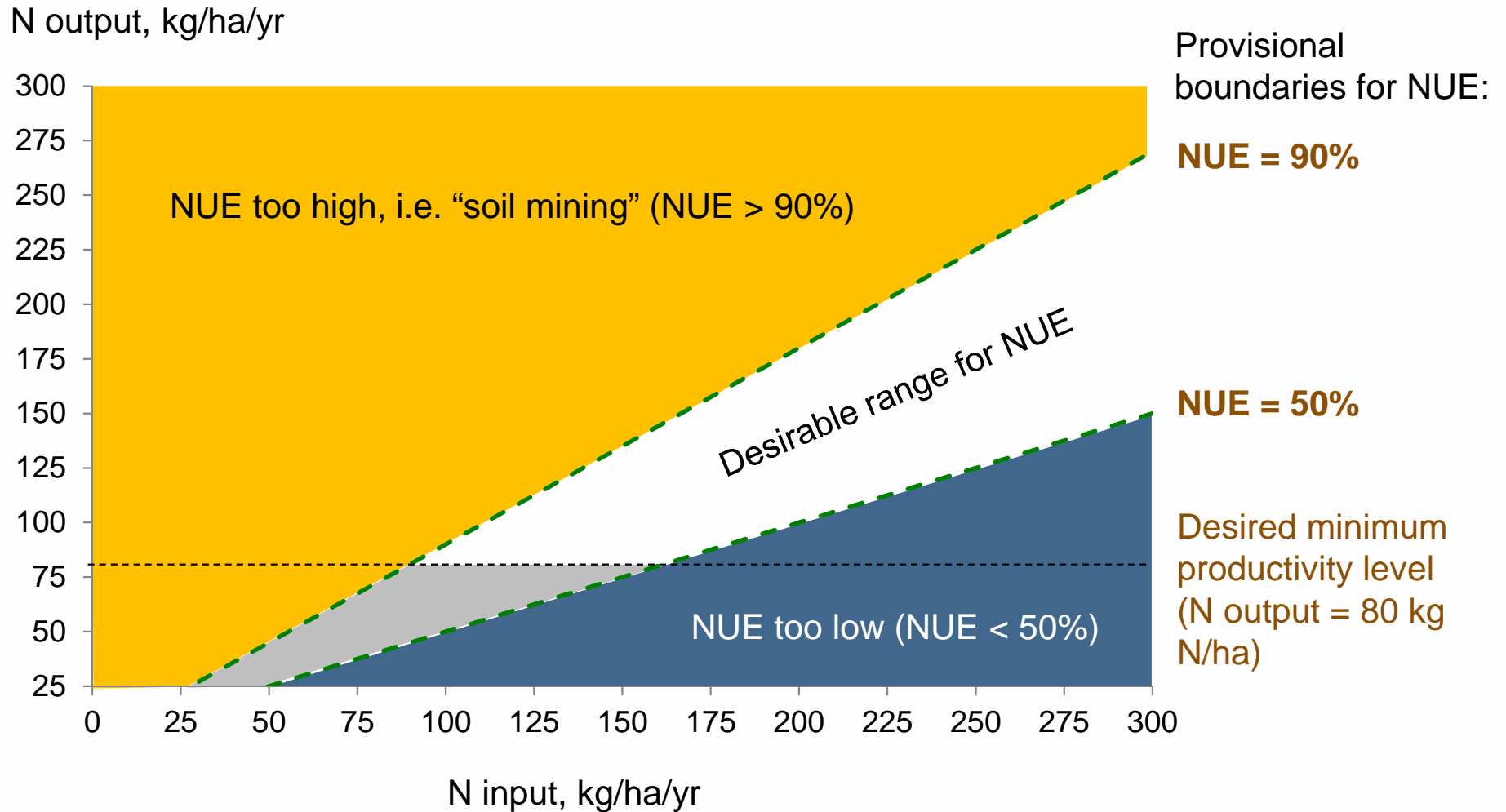
<b>N input</b>	<b>N output</b>
Mineral fertilizers	Crop products
Feed and fodder (net)	Animals (net)
Biological nitrogen fixation	Animal products (milk, egg, wool)
Atmospheric N deposition	
Compost and sewage sludge	
Seed and planting material	
Bedding material	
Animal manure (net)	

# Definition of acceptable boundaries for N output/input ratios giving a desirable range for NUE (all numbers are provisional for illustration only)

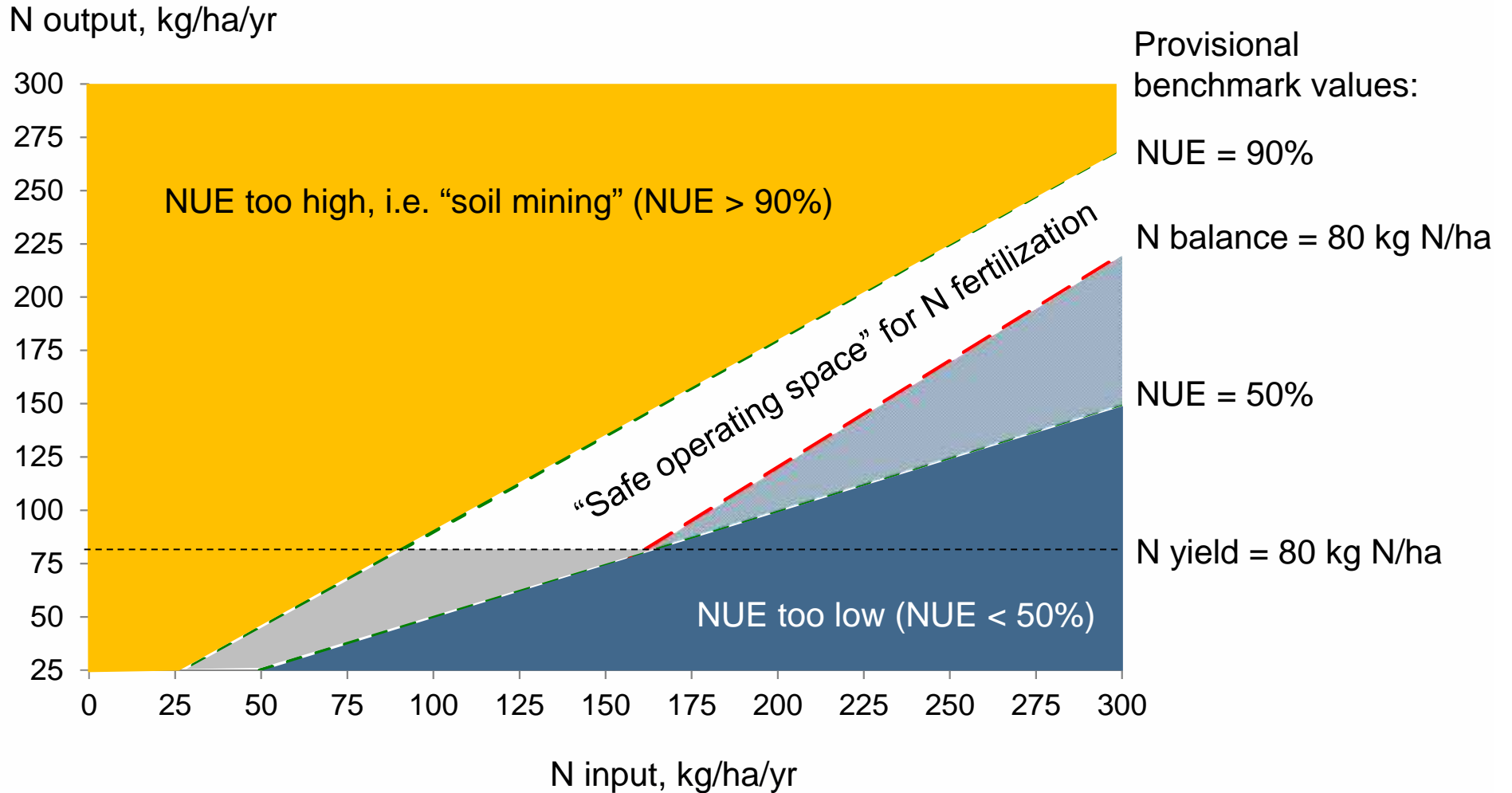




# Definition of acceptable boundaries for N output/input ratios giving a desirable range for NUE – supplemented by a desired minimum productivity level (all numbers are provisional for illustration only)



# Definition of acceptable boundaries for N output/input ratios giving a desirable range for NUE – supplemented by a target value for N balance (all numbers are provisional for illustration only)

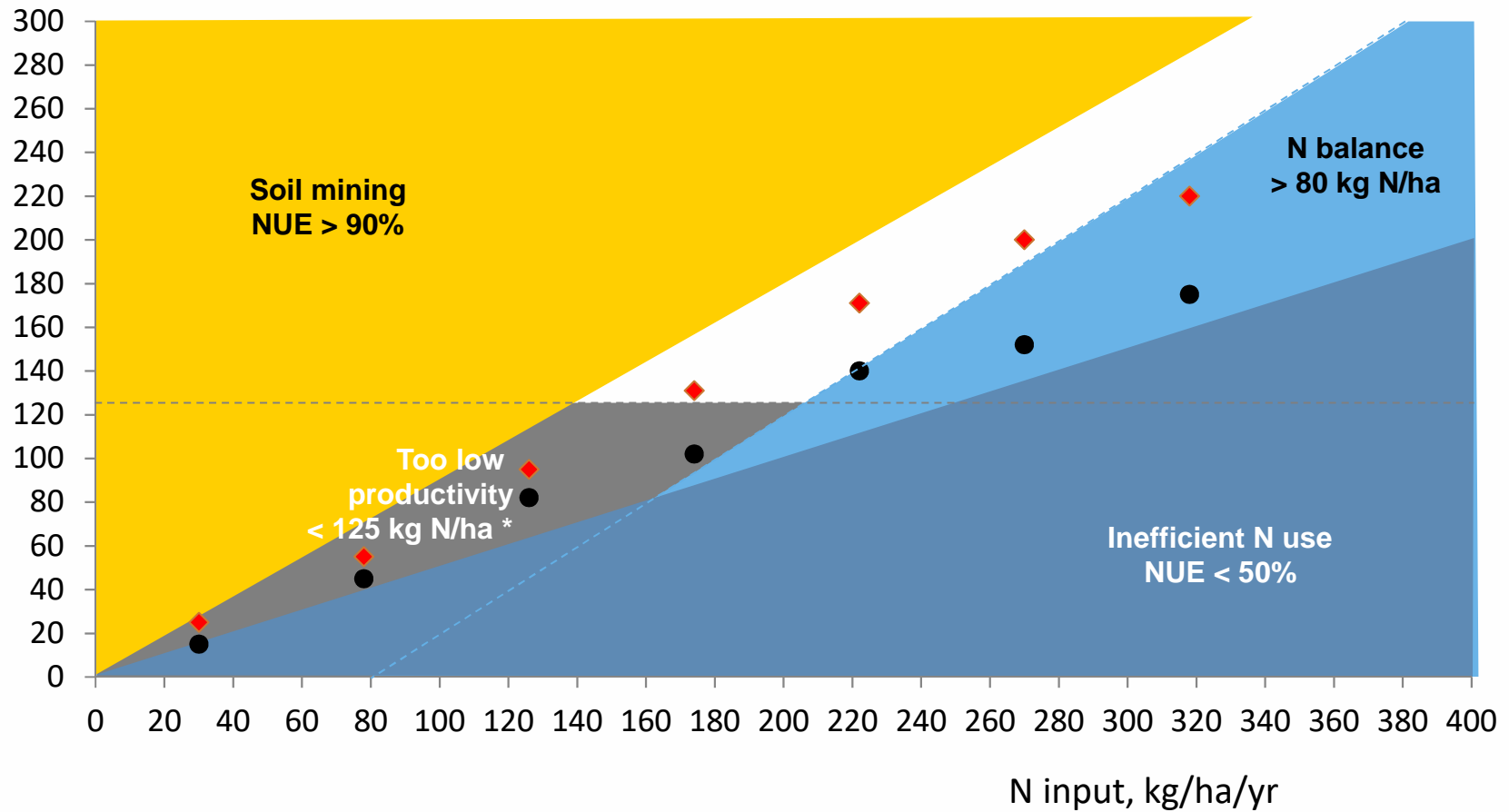


# Application of the new NUE indicator system

- 1) Winter wheat grown at different N rates in a long-term experiment (Broadbalk Experiment, Rothamsted/UK)
  - as monoculture wheat and
  - in a rotation with other crops.
  
- 2) Winter wheat grown at different N rates in one-year field trials (Yara R&D, Hanninghof/DE) with focus on economic optimum N fertilization
  - using in-season plant analysis (N-Tester) for N fertilizer recommendation

# Long-term N response trial (Broadbalk, UK) with winter wheat as monoculture (black) and in a rotation (red)

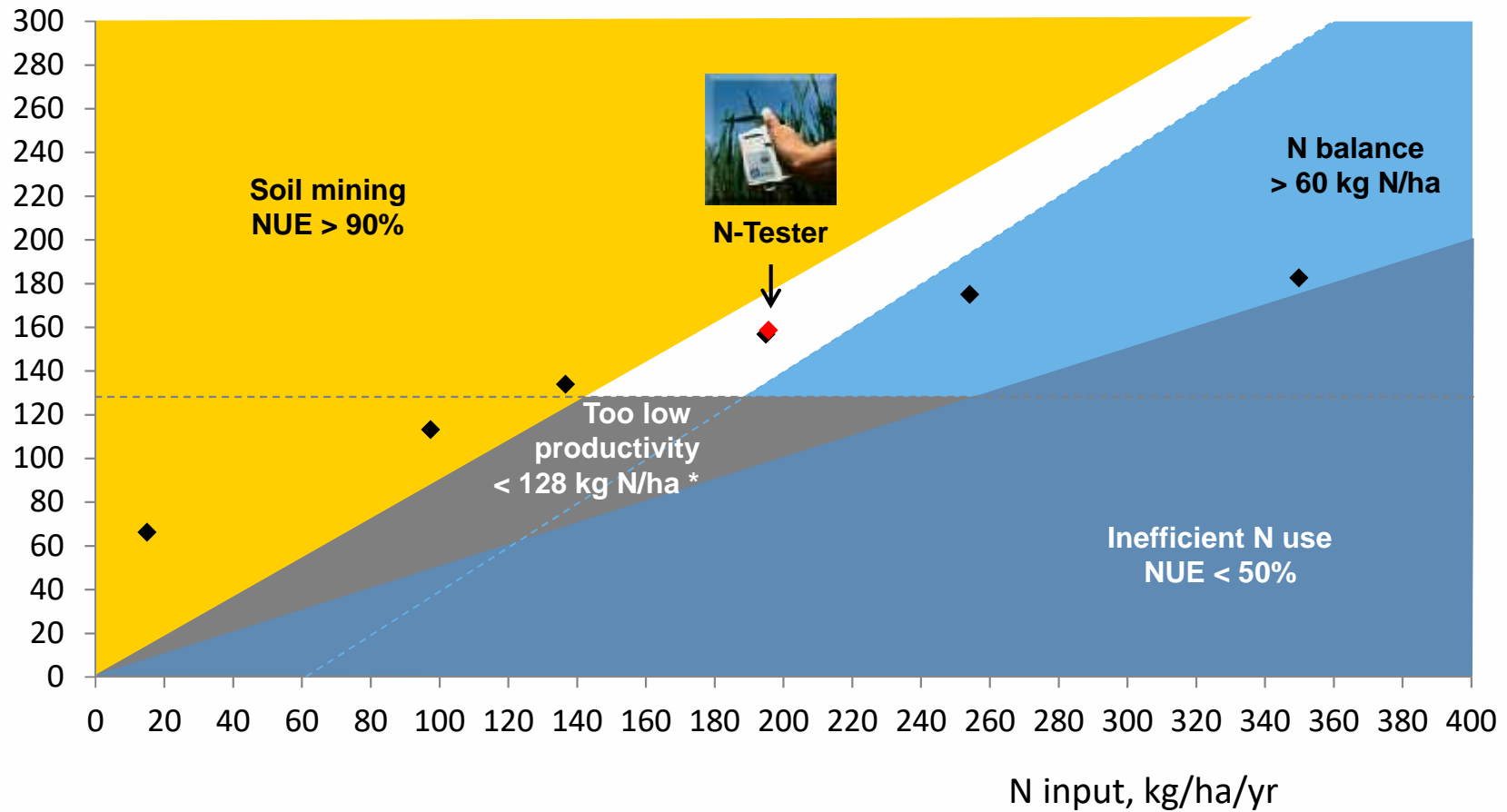
N output, kg/ha/yr



\* 7.26 t/ha \* 0.86 \* 20 kg N/t (avg. wheat yield in UK in 2011-2013, FAOSTAT database (2016))

# Average of 189 one-year N response trials with winter wheat on farmer fields all over Germany (2003-2015)

N output, kg/ha/yr



\* 7.45 t/ha \* 0.86 \* 20 kg N/t (avg. wheat yield in DE in 2011-2013, FAOSTAT database (2016))

# Nitrogen Use Efficiency (NUE) – an indicator for the utilization of nitrogen: summary

NUE assessment shall take 3 dimension into account

- N output / N input = NUE -> resource use efficiency & long-term sustainability
- N output = N yield -> productivity & economy
- N input – N output = N surplus -> environmental risks

Advantage of this approach

- Growers will not be limited by a ceiling in N fertilizer use but can aim for a target corridor.
- The N fertilizer rate alone is no criterion for efficiency.
- The approach can be used demonstrate performance of improved fertilizer management e.g. through precision farming

Challenge

- The concept needs explanation
- Crop and region specific target or benchmark values need to be developed, preferably for complete crop rotations



**Knowledge grows**

**Thank you for your attention**