

# Realistic nitrogen use efficiency goals in dairy production systems: a review and case study examples



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## Key question addressed

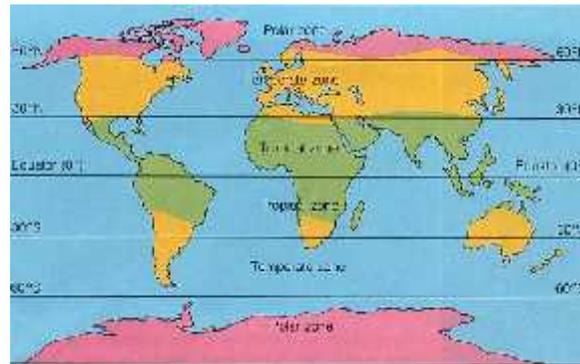
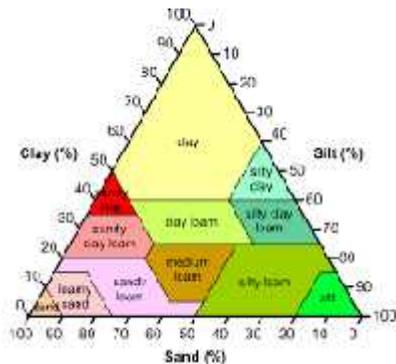
What are realistic nitrogen use efficiency goals for dairy systems?

That depends....

## Type of system



## Soil and climatic context



## Desired impacts

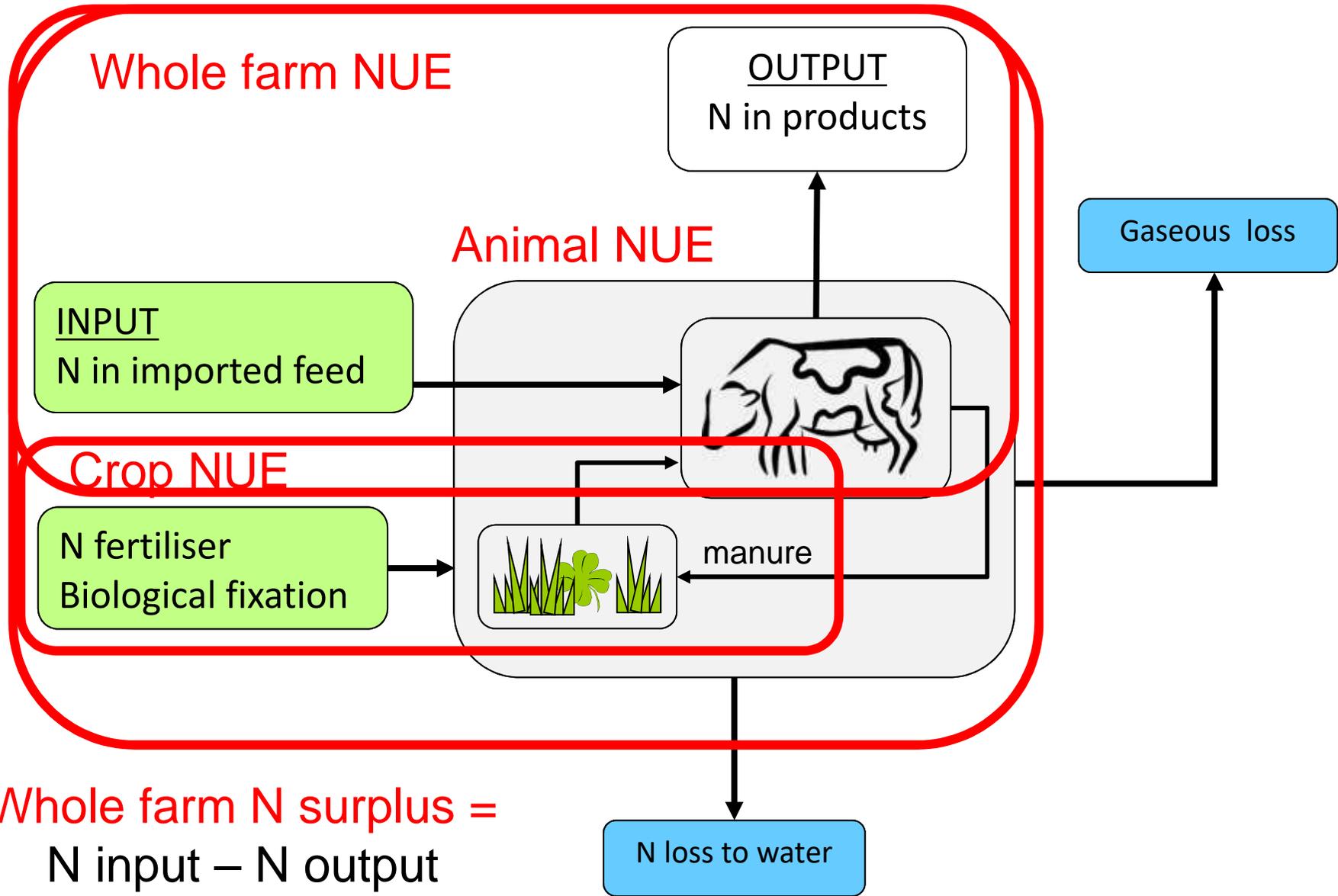


# Outline

- Definitions
- Summary of published dairy NUE results
- N Input/output framework EU nitrogen expert panel
- NZ catchments case study
- Key conclusions/discussion points



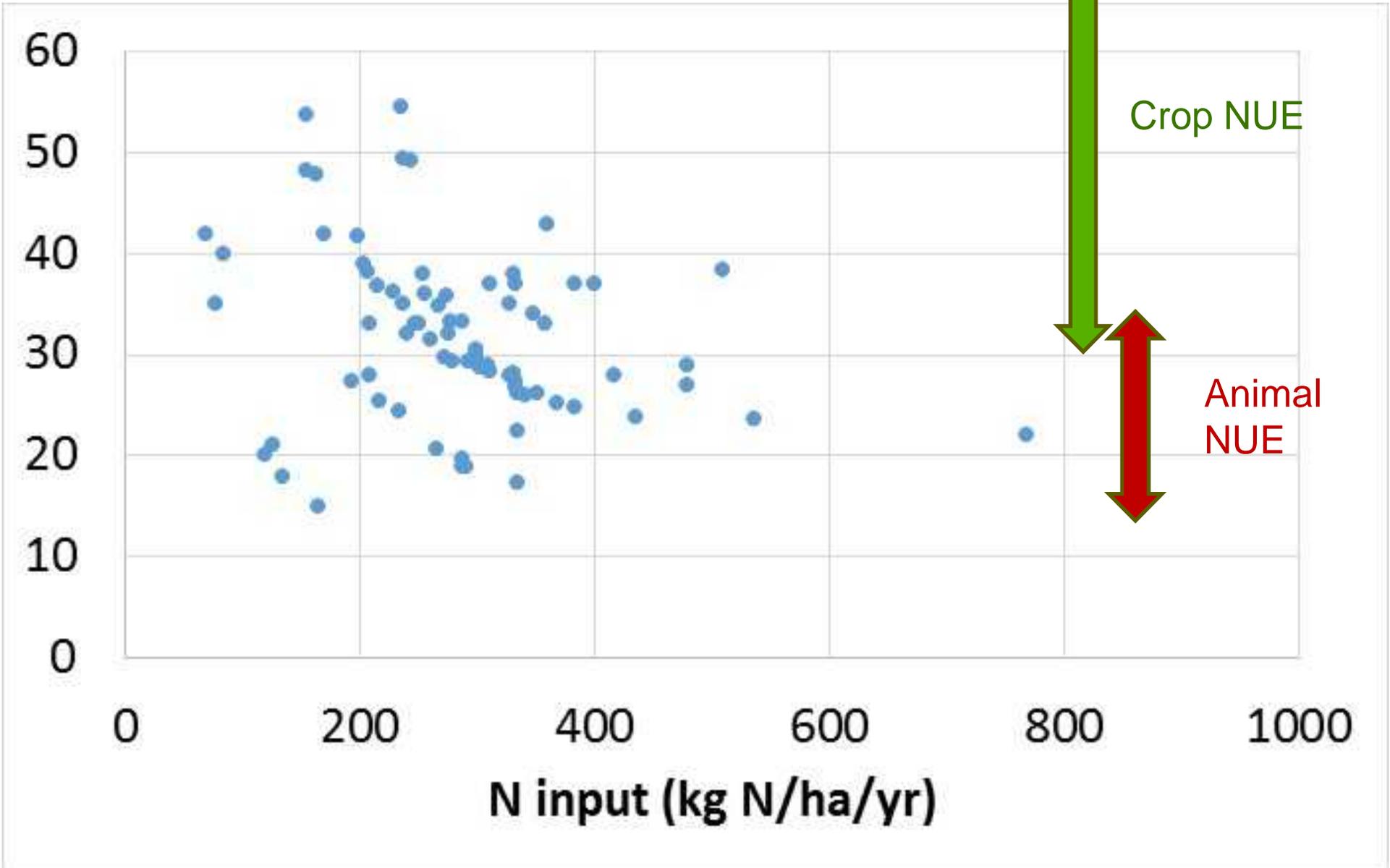
# Definitions



Whole farm N surplus =  
N input – N output

# Whole farm NUE (%) - dairy systems

Up to 90%

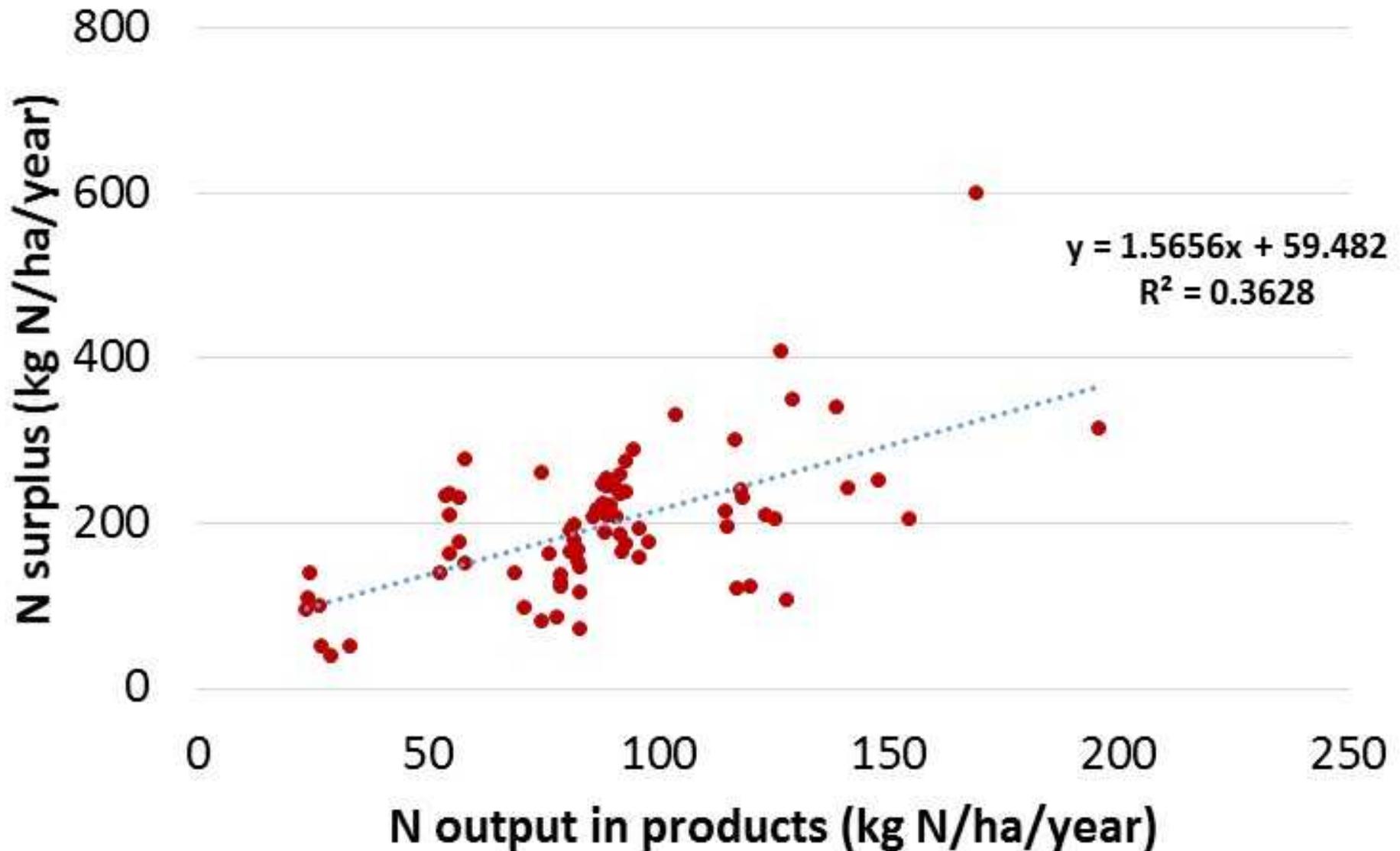


Crop NUE

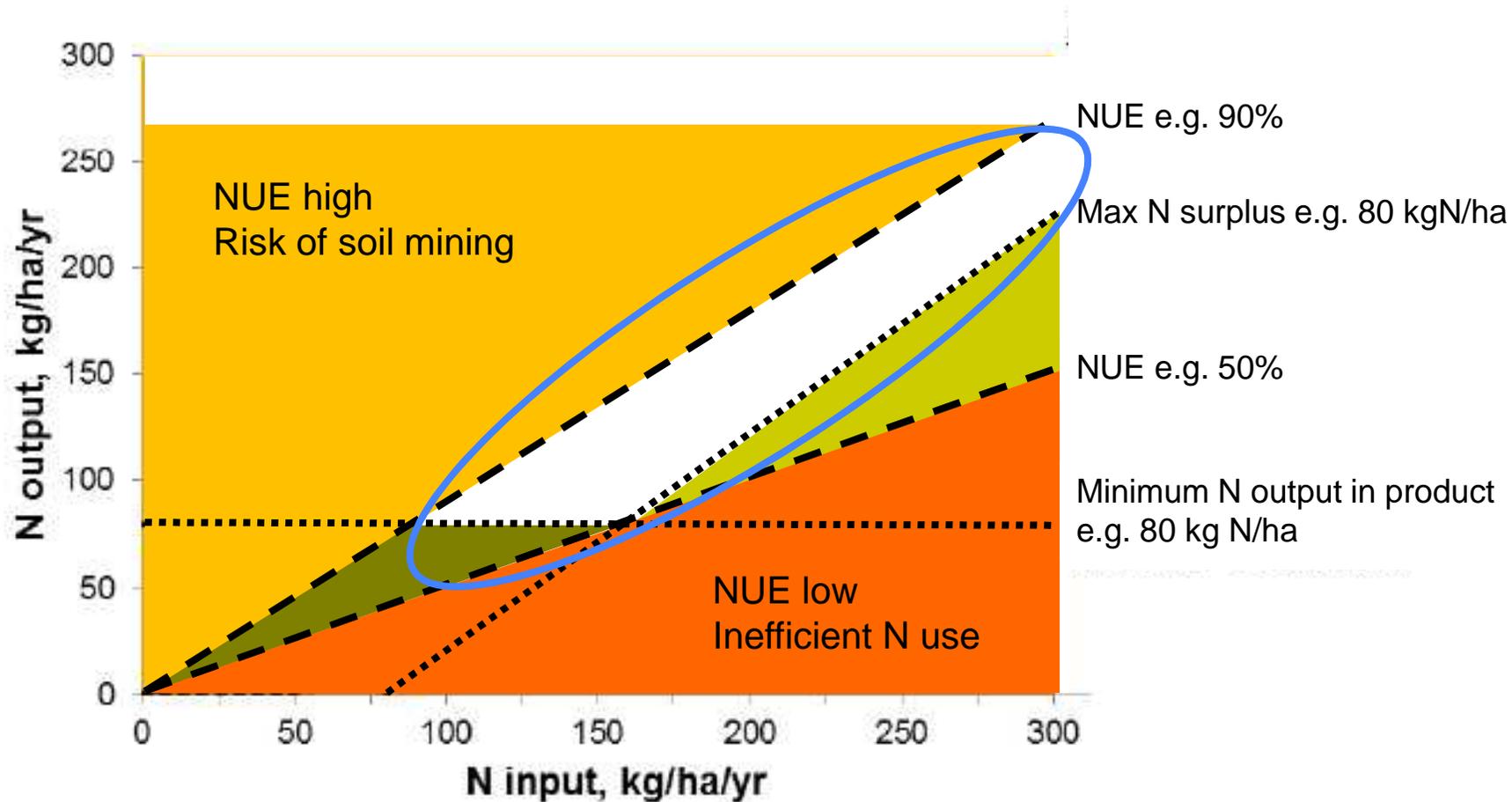
Animal  
NUE

# Challenge of striking the right balance

– productivity vs N surplus

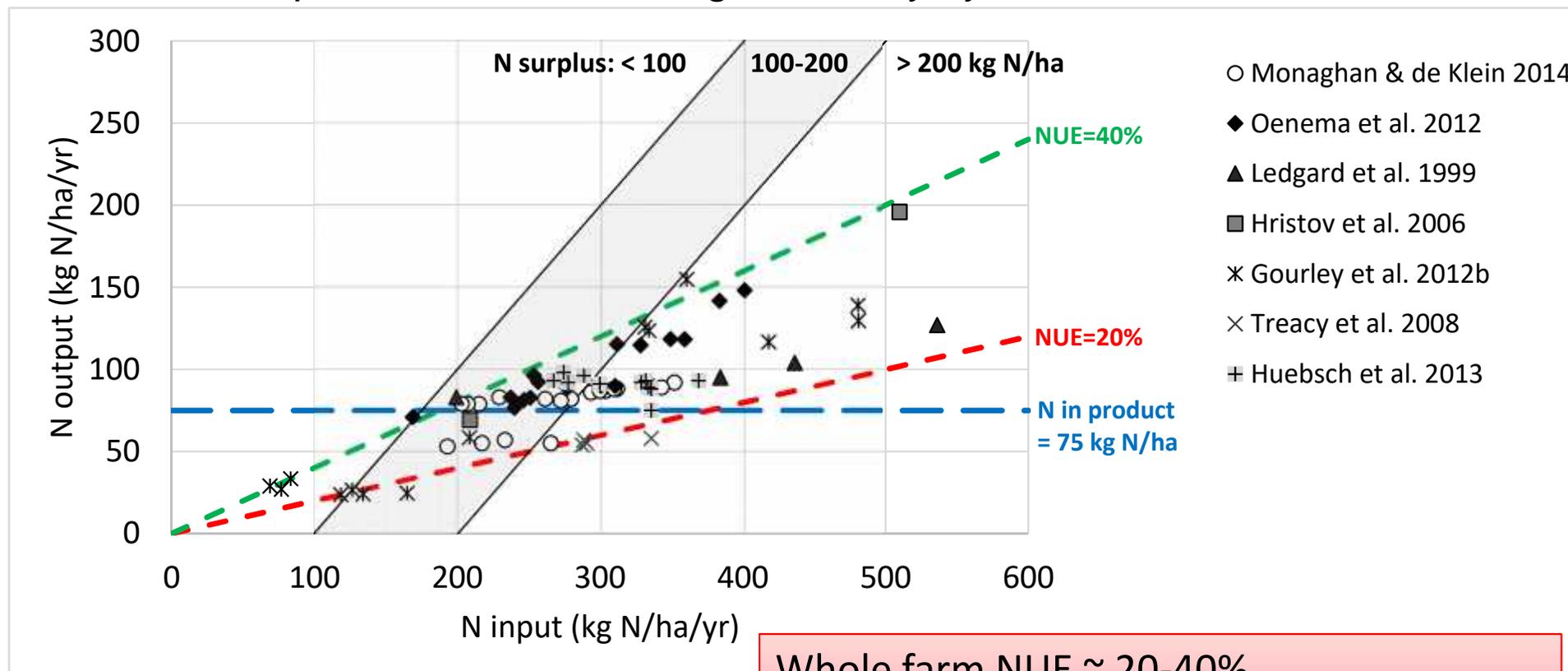


# N input – output framework



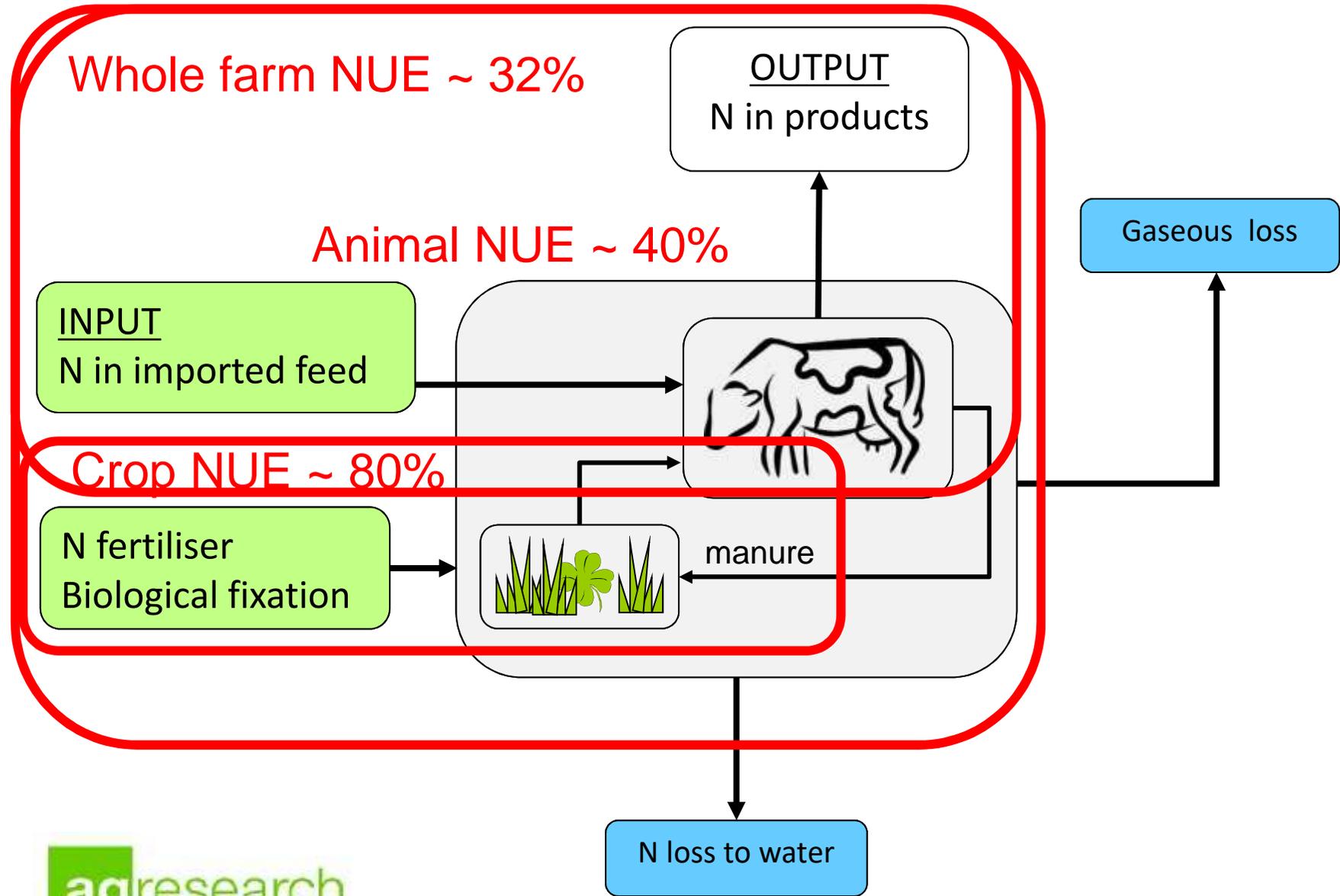
# Results mapped onto input-output framework

## Experimental data from global dairy systems



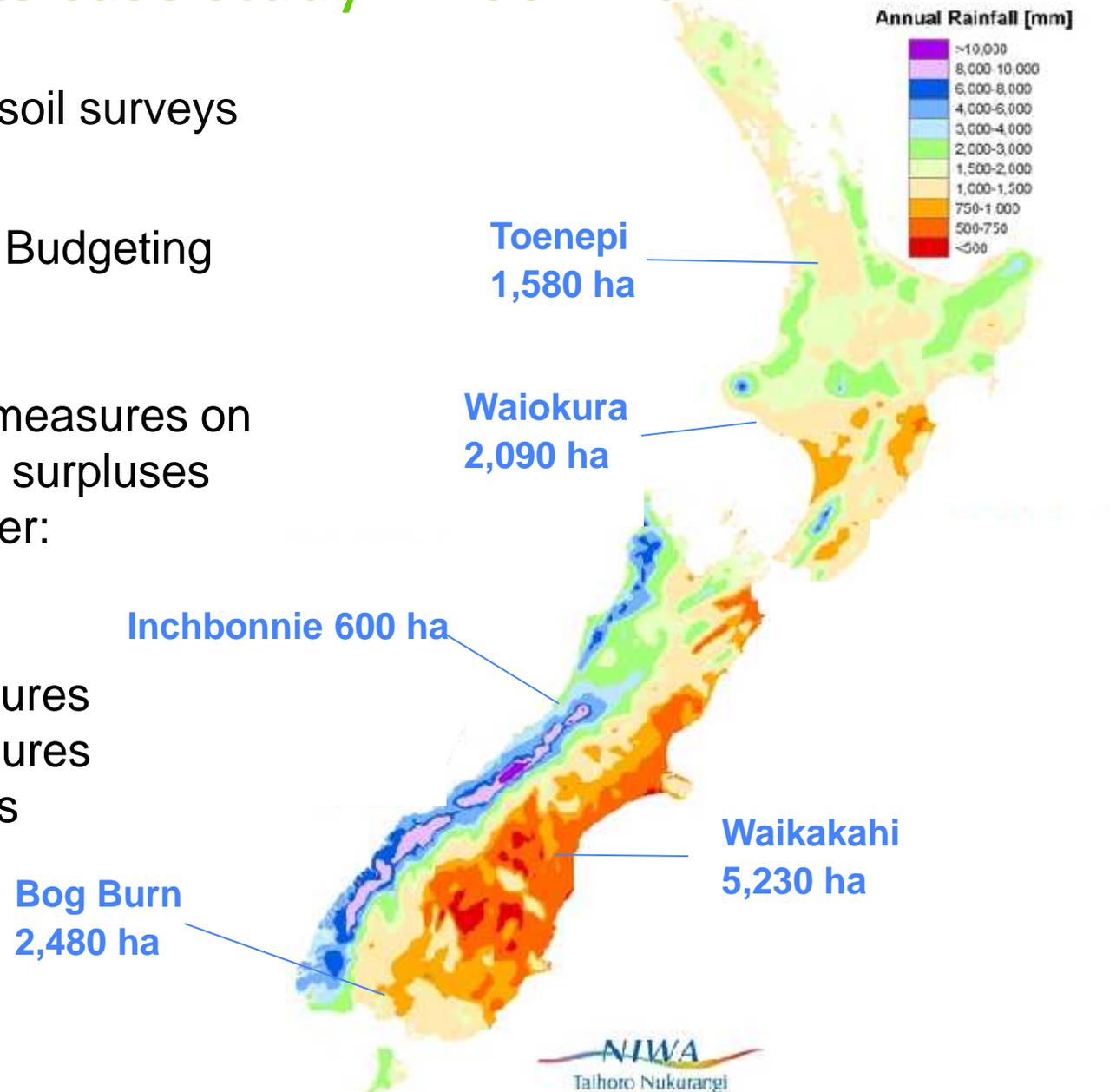
Whole farm NUE ~ 20-40%  
75% of farms: N output > 75 kg N/ha  
50% of farms: N surplus > 200 kg N/ha  
7% of farms: N surplus < 100 kg N/ha

# Theoretical limits?



# NZ catchments case study – 2001-2011

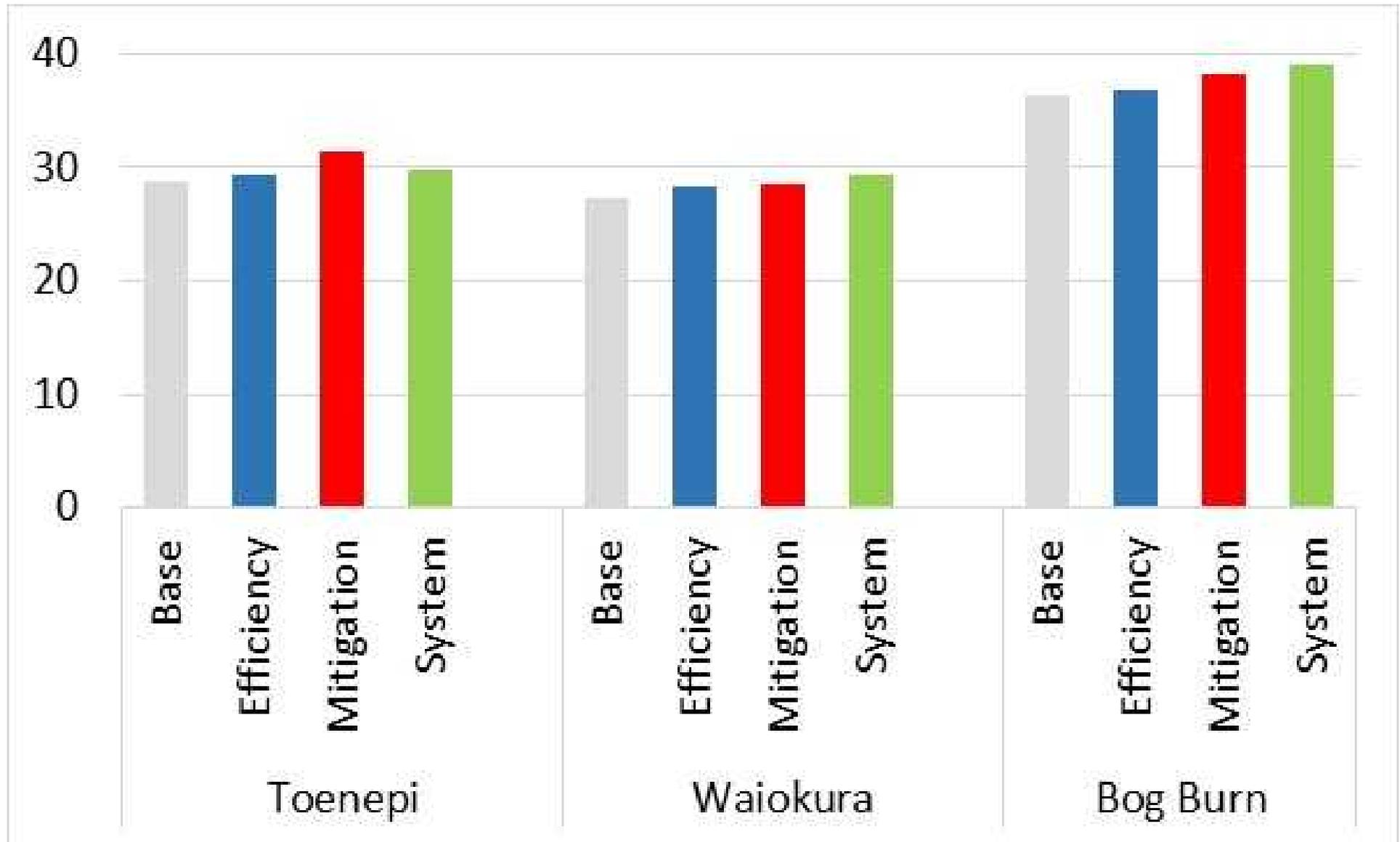
- Bi-annual farm and soil surveys
- Overseer® Nutrient Budgeting Model
- Effect of mitigation measures on Whole farm NUE, N surpluses and N losses to water:
- Measures
  - Efficiency measures
  - Mitigation measures
  - System changes



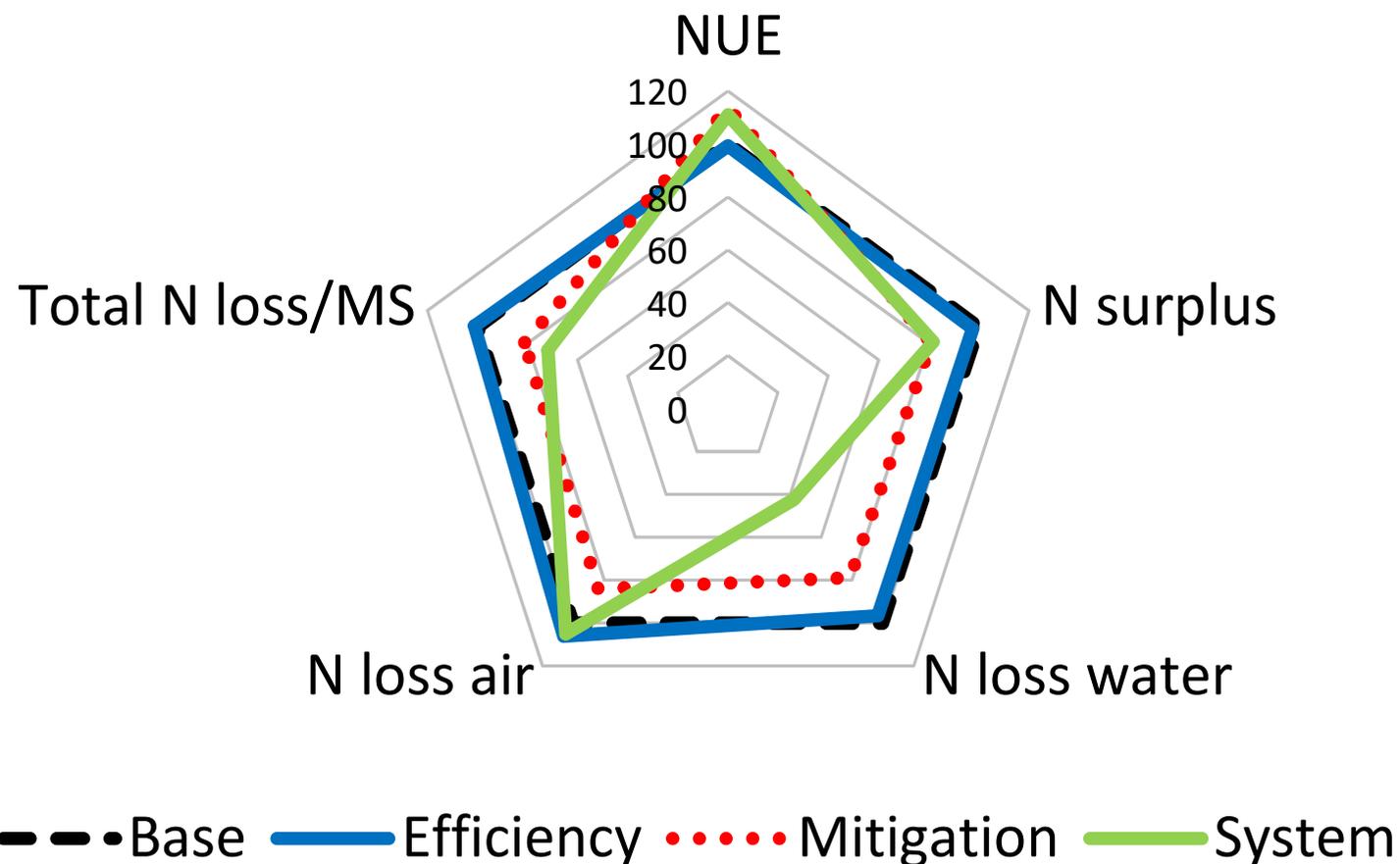
## Mitigation measures – progressive implementation

Aim	Potential options
Increase Crop NUE	Improved fertilizer and manure management
Increase Animal NUE	Higher genetic merit animals Lower cow replacement rate Better quality feed (optimizing protein & ME contents) <p style="text-align: right; color: blue; font-weight: bold;">Efficiency</p>
Reduce N losses	Nitrification and urease inhibitors Restricted grazing to avoid urine deposition at high risk times <p style="text-align: right; color: red; font-weight: bold;">Mitigation</p> <p style="text-align: right; color: green; font-weight: bold;">System</p>

## Effect of measures on Whole farm NUE (%)



# Effect of measures on other N metrics relative to Base farm – Waikakahi



## Key findings of NZ catchment study

‘Between-catchment’ variability in NUE > ‘within-catchment’

NUE largely insensitive to mitigation options, but N surpluses and especially N leaching losses were reduced

To simultaneously achieve higher NUE and lower N surplus → better utilise N within the system

### Key management attributes

- reduce fertiliser/feed N inputs,
- reduce number of less productive animals,
- grazing management to reduce the risk of N losses in autumn/winter

## Other considerations

All N metrics based on estimates of N inputs and N outputs

- Need to be adequately measured or estimated, despite the methodological challenges (e.g. fixation in clover-based systems)

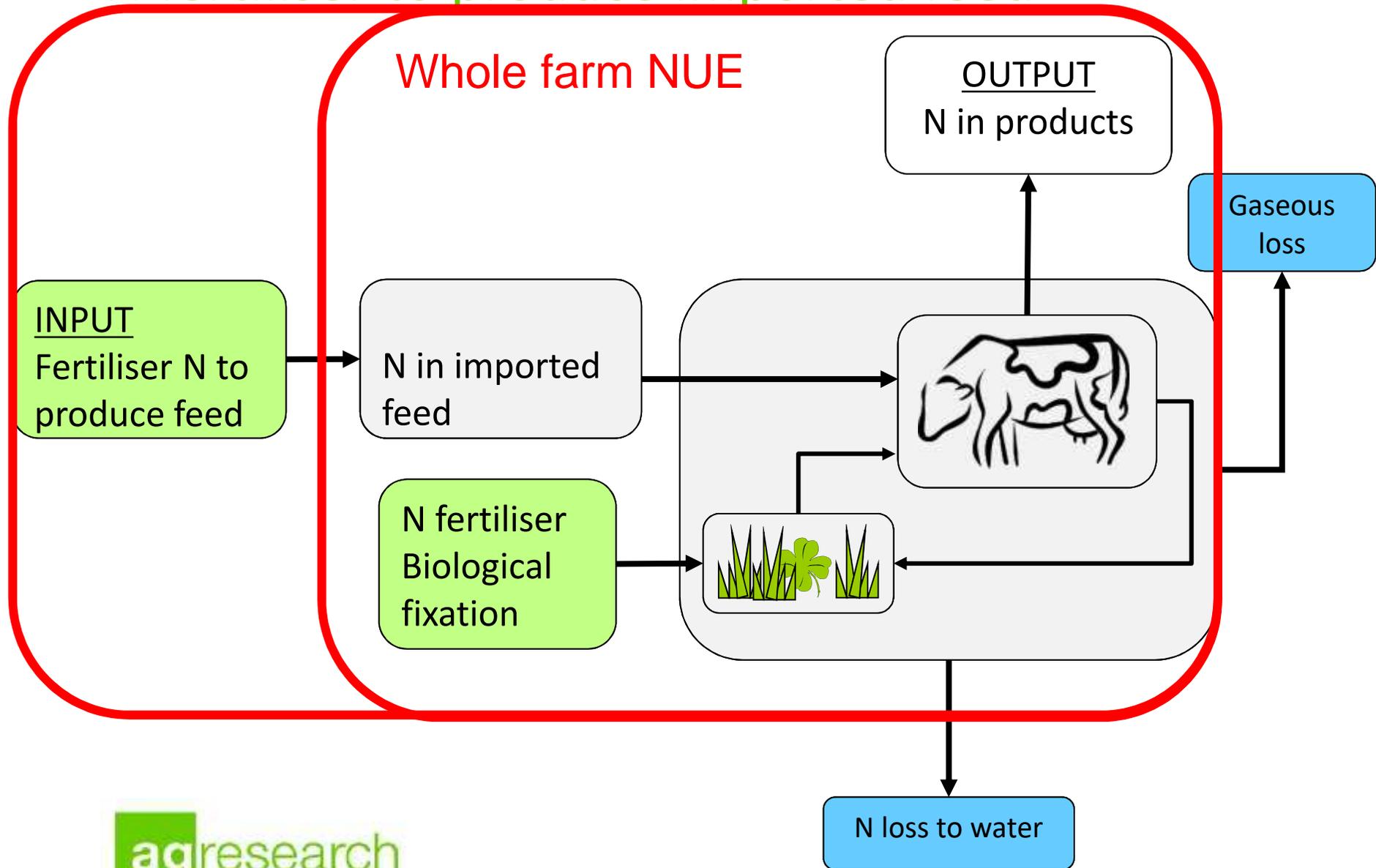
Agreement required on what should be included in N input and output terms.

What is the system boundary?

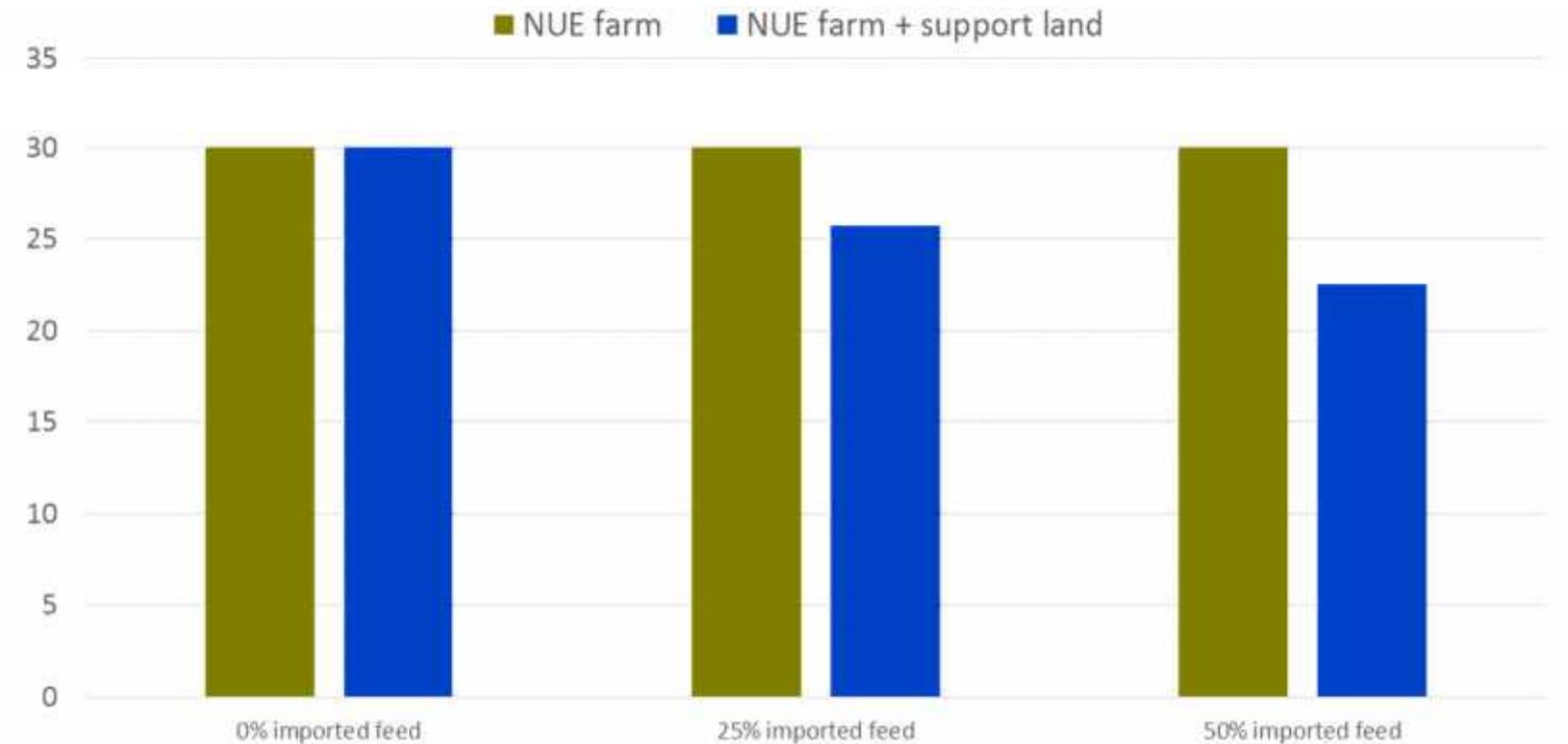
~ 150-200 kg N/ha/yr



# N fertiliser to produce imported feed



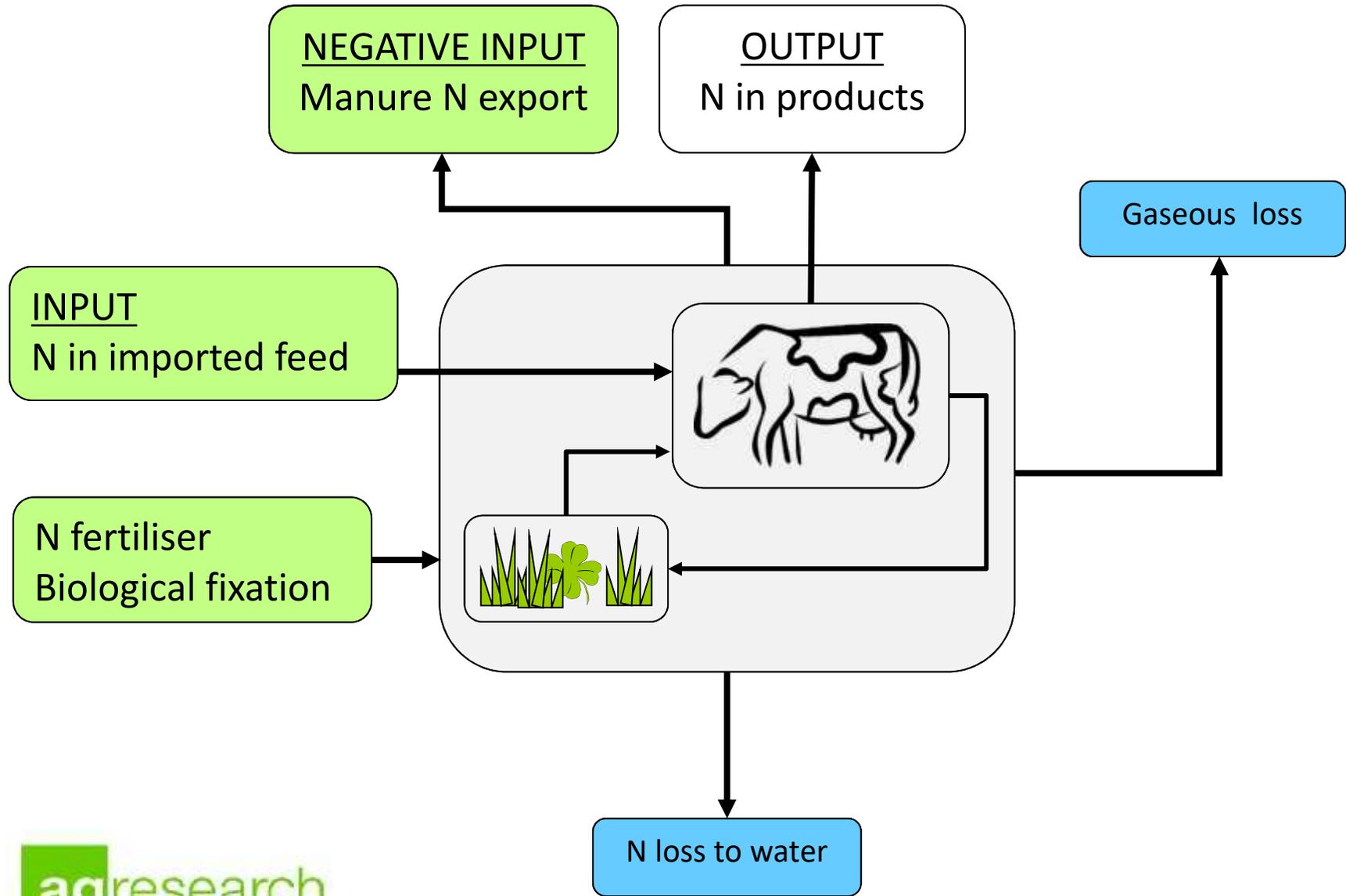
# Effect of system boundary on NUE (%)



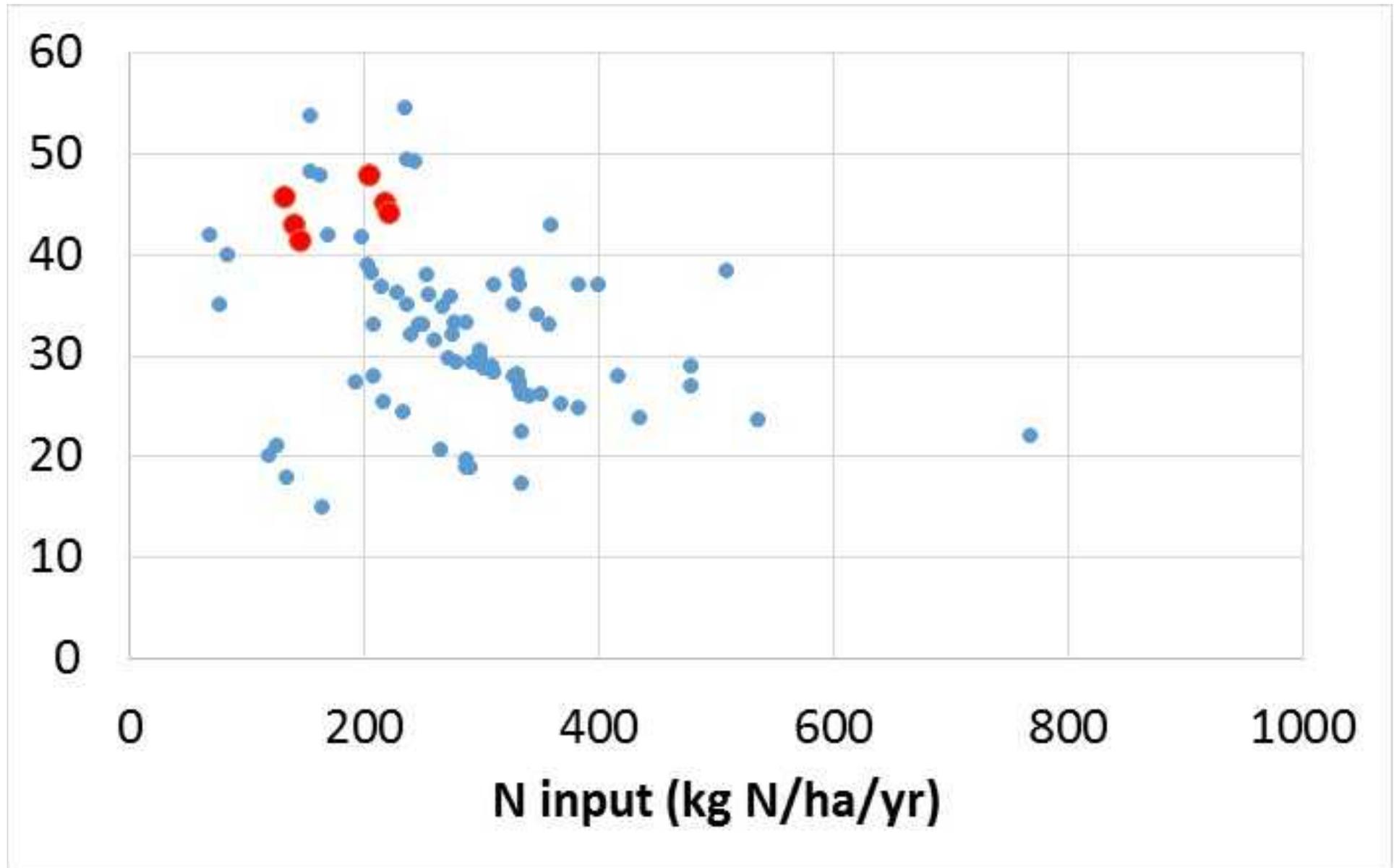
N input:	300 kg N/ha (fert,fix)	225N fert, fix + 75N feed	150N fert,fix + 150N feed
N output:	90 kg N/ha (milk, meat)	90N	90N

Assumes Crop NUE = 60%

# Manure exported off-farm



## NUE (%) global dairy systems



## In conclusion...

Realistic NUE goals for dairy systems requires:

- Consideration of the agro-climatic context
- Theoretical limit ~ 35 % ?
- Agreement on how it is calculated – [Role for INMS...](#)
- Understanding impact they are primarily aimed at



**Crop** and **Animal NUE** valuable indicators for optimising fertiliser and feed use

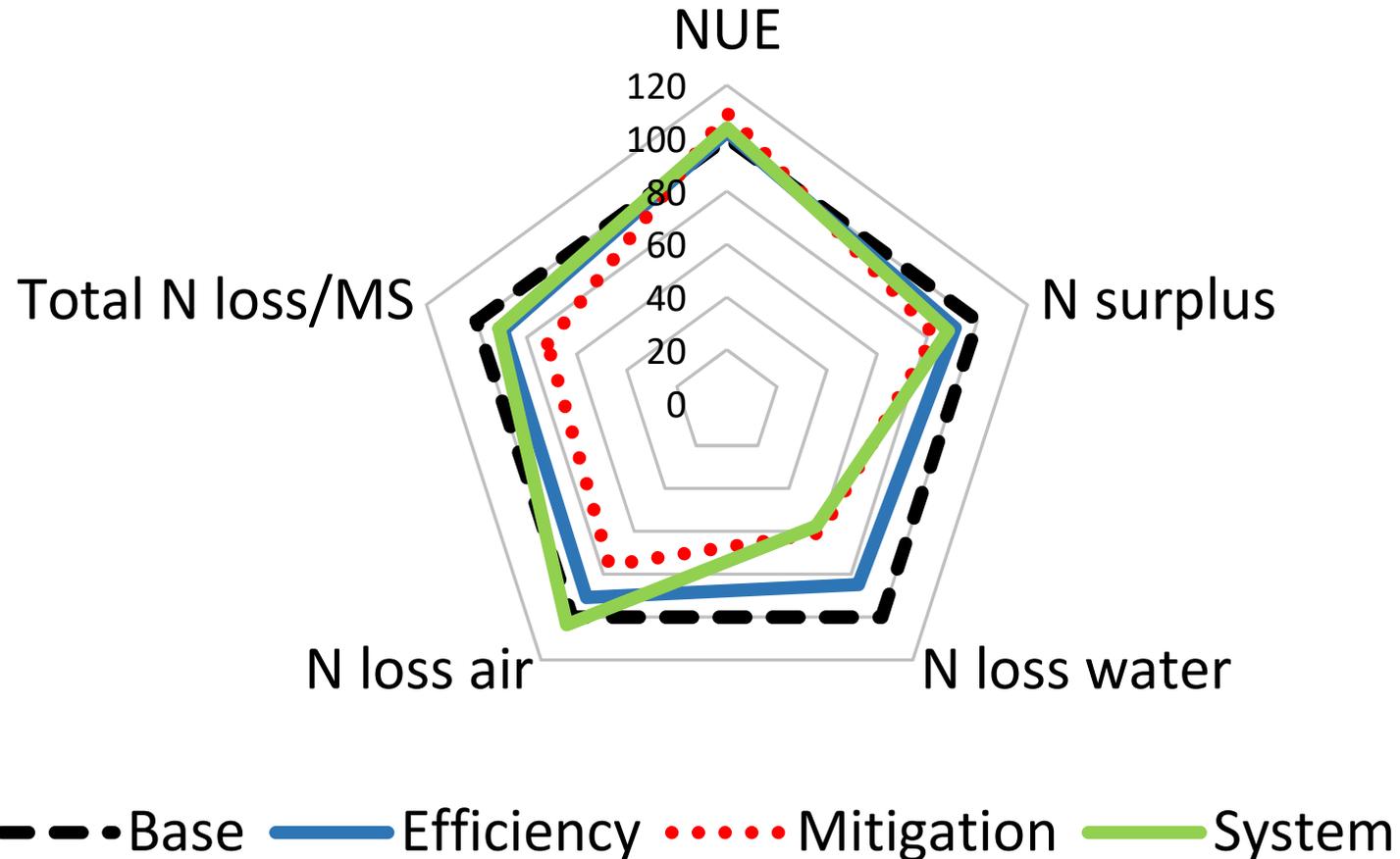


Whole-farm NUE of limited value for environmental goals; **N surplus** more useful

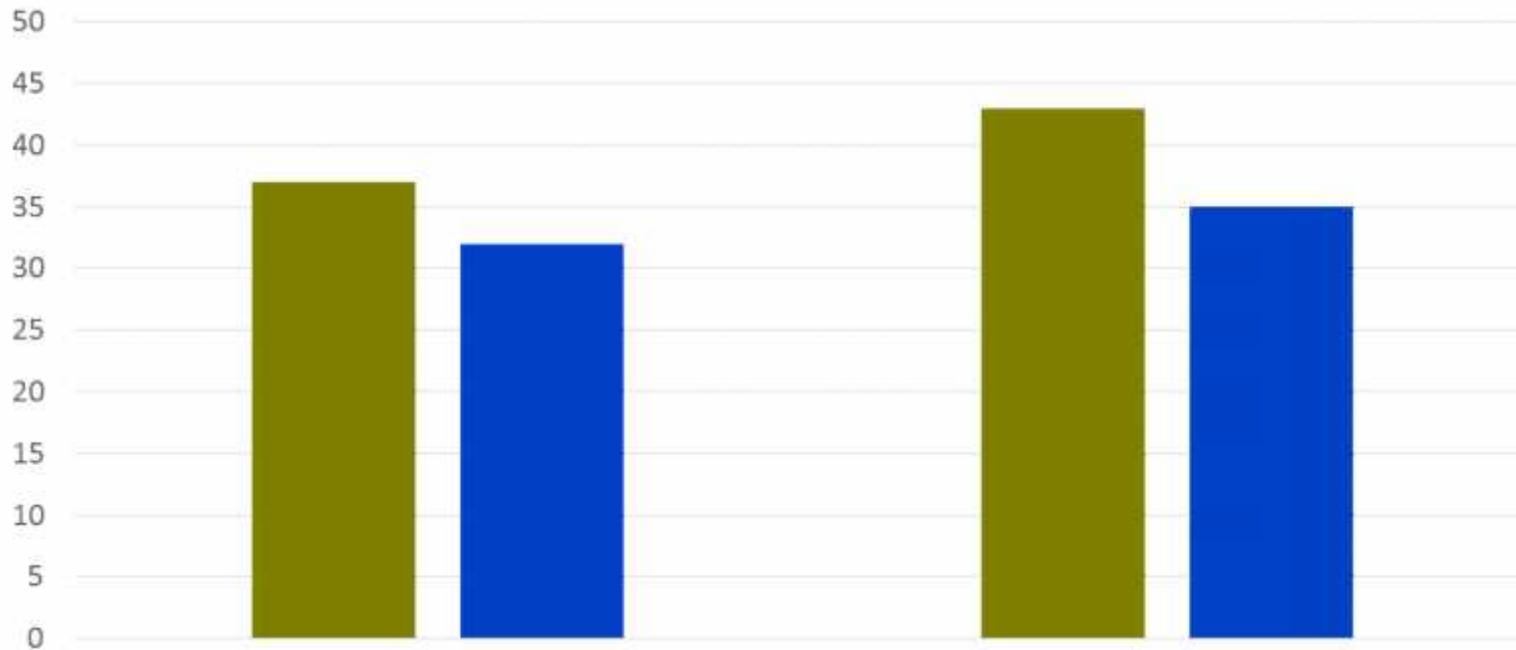
Thank you for your attention



# Effect of measures on N metrics relative to Base farm – Toenepi



# Effect of negative inputs on NUE (%)



N input:	300N (fert,fix)	300N - 20N	300N (fert, fix)	300N - 40N
N output:	90N (milk) 20N (feed or manure)	90N	90N (milk) 40N (feed or manure)	90N