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….

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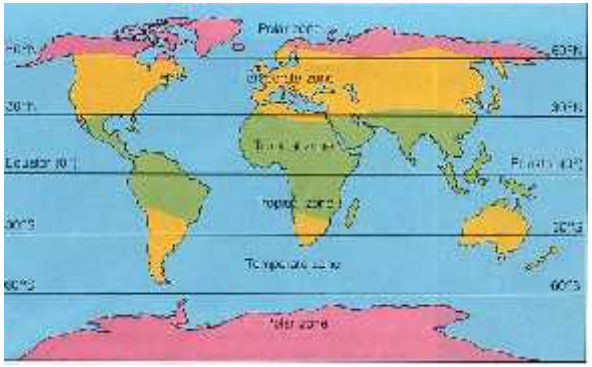
Type of system



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

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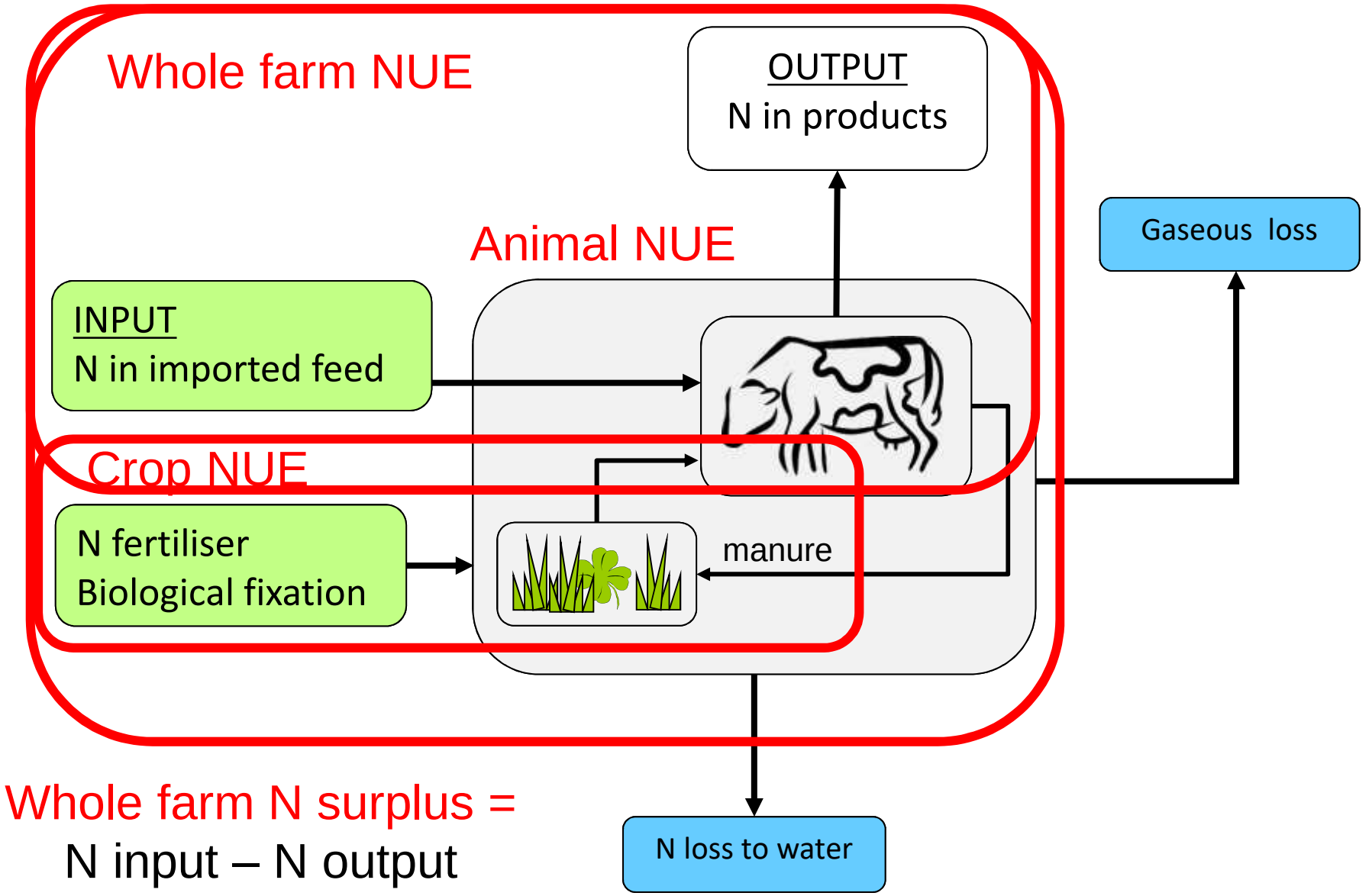
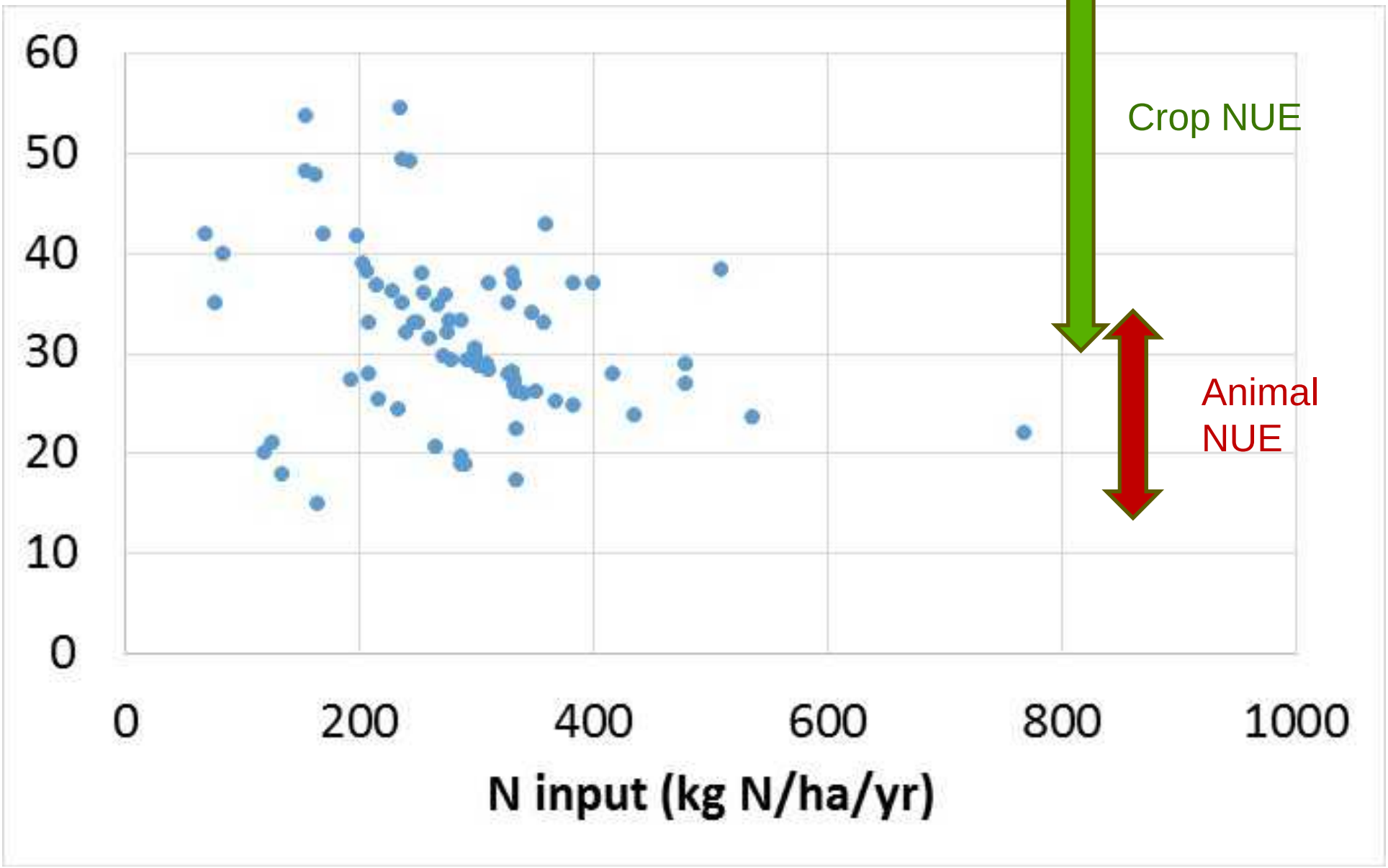
Definitions



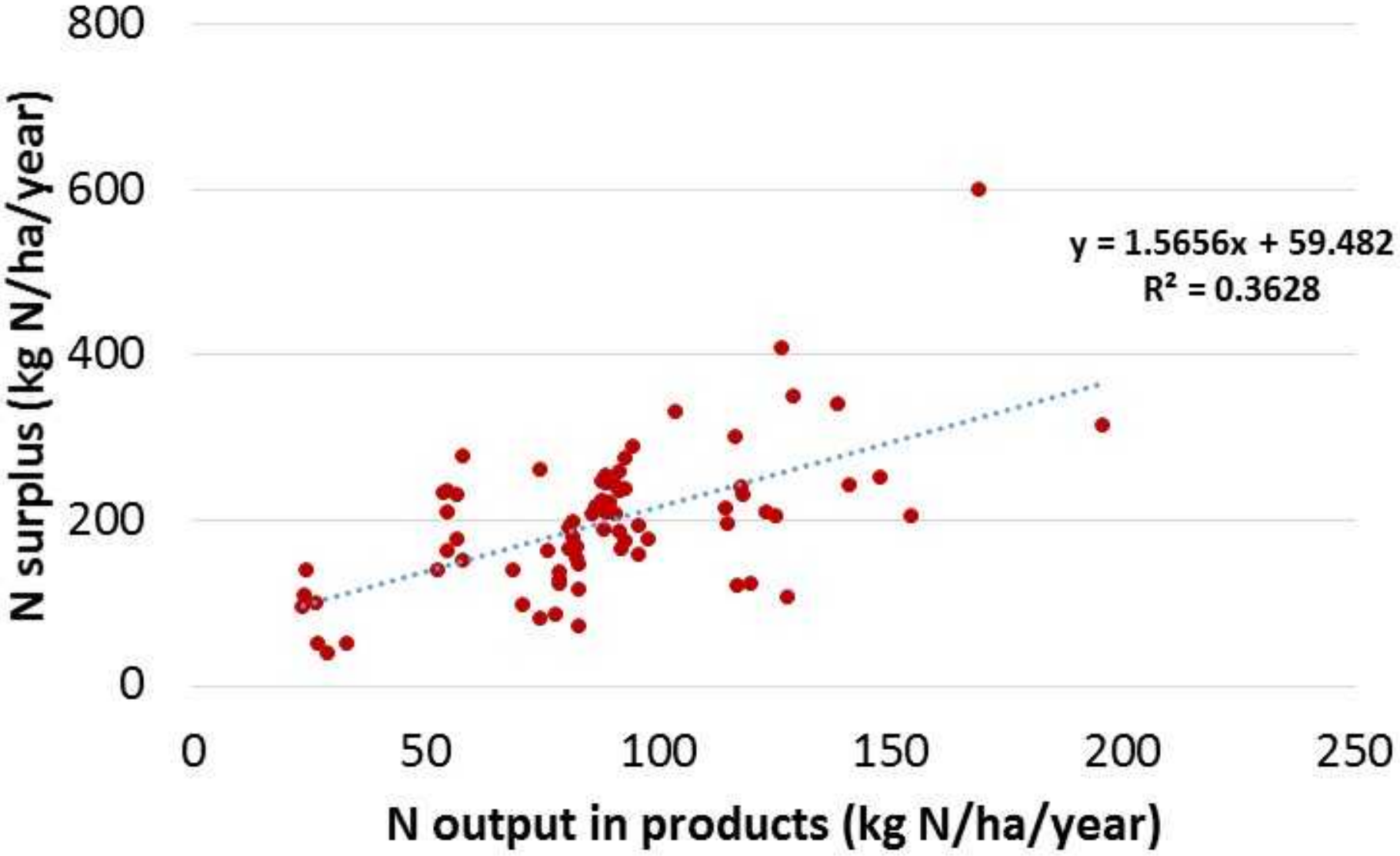
Whole farm N surplus =

N input – N output

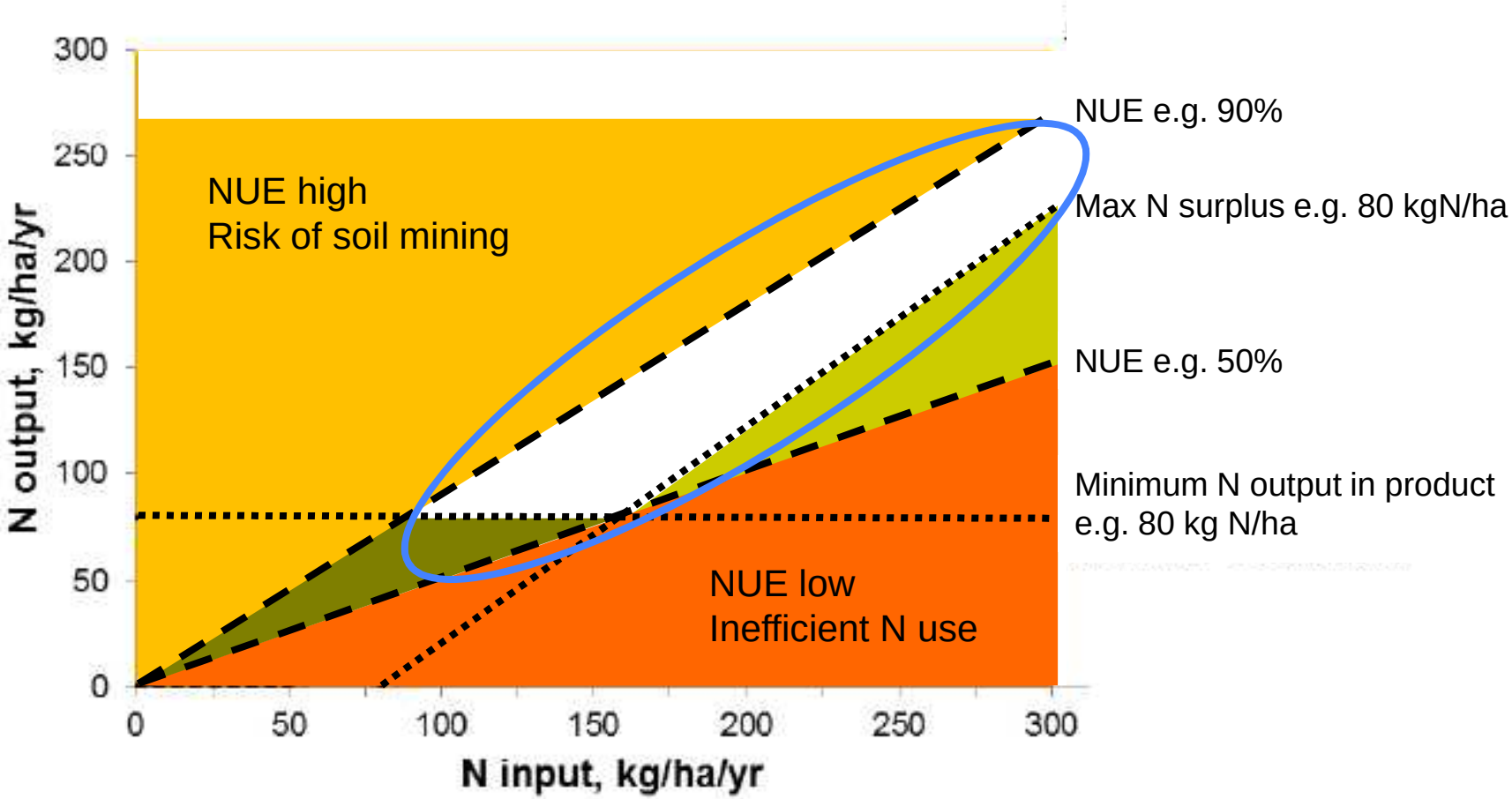
Whole farm NUE (%) - dairy systems



Challenge of striking the right balance
– productivity vs N surplus



N input – output framework



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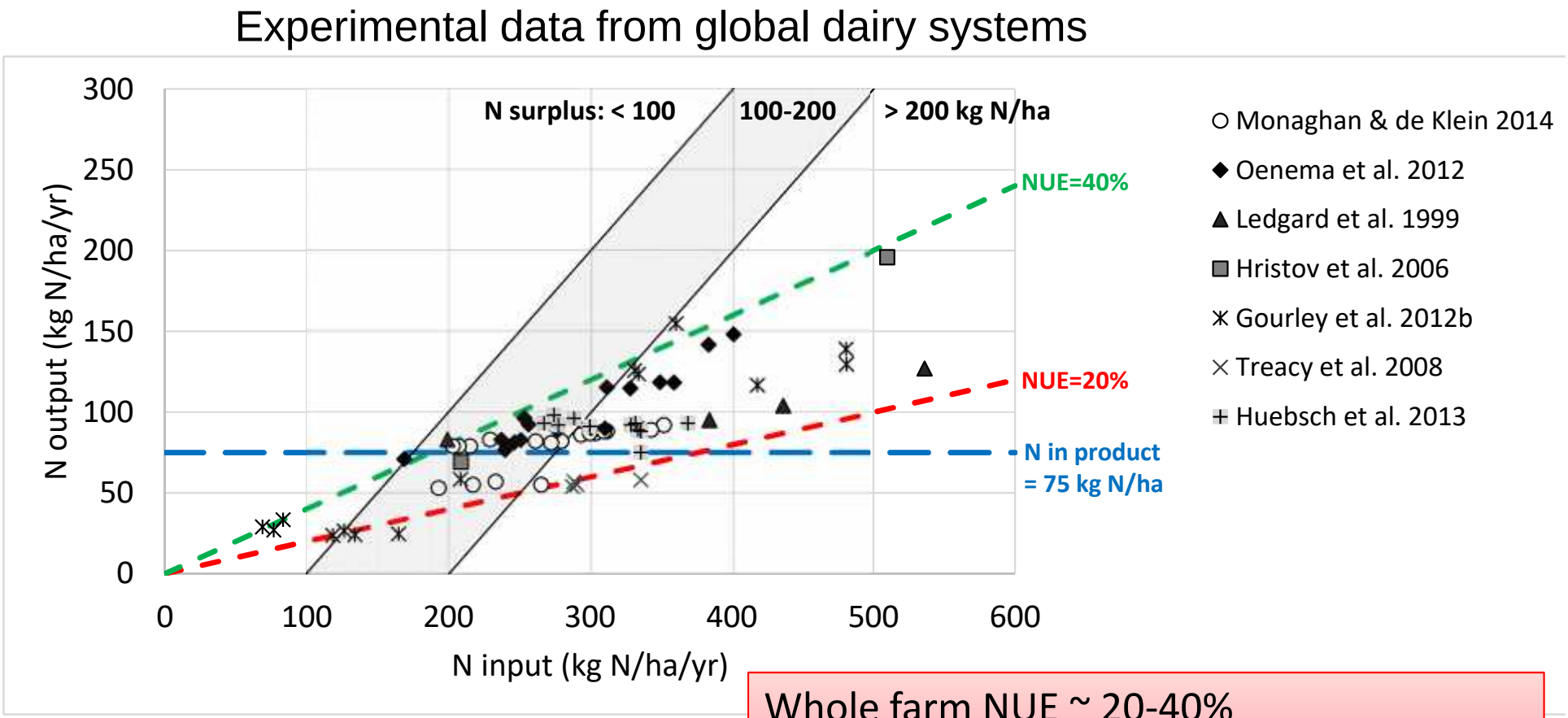
EU Nitrogen Expert Panel, 2015

Results mapped onto input-output framework



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

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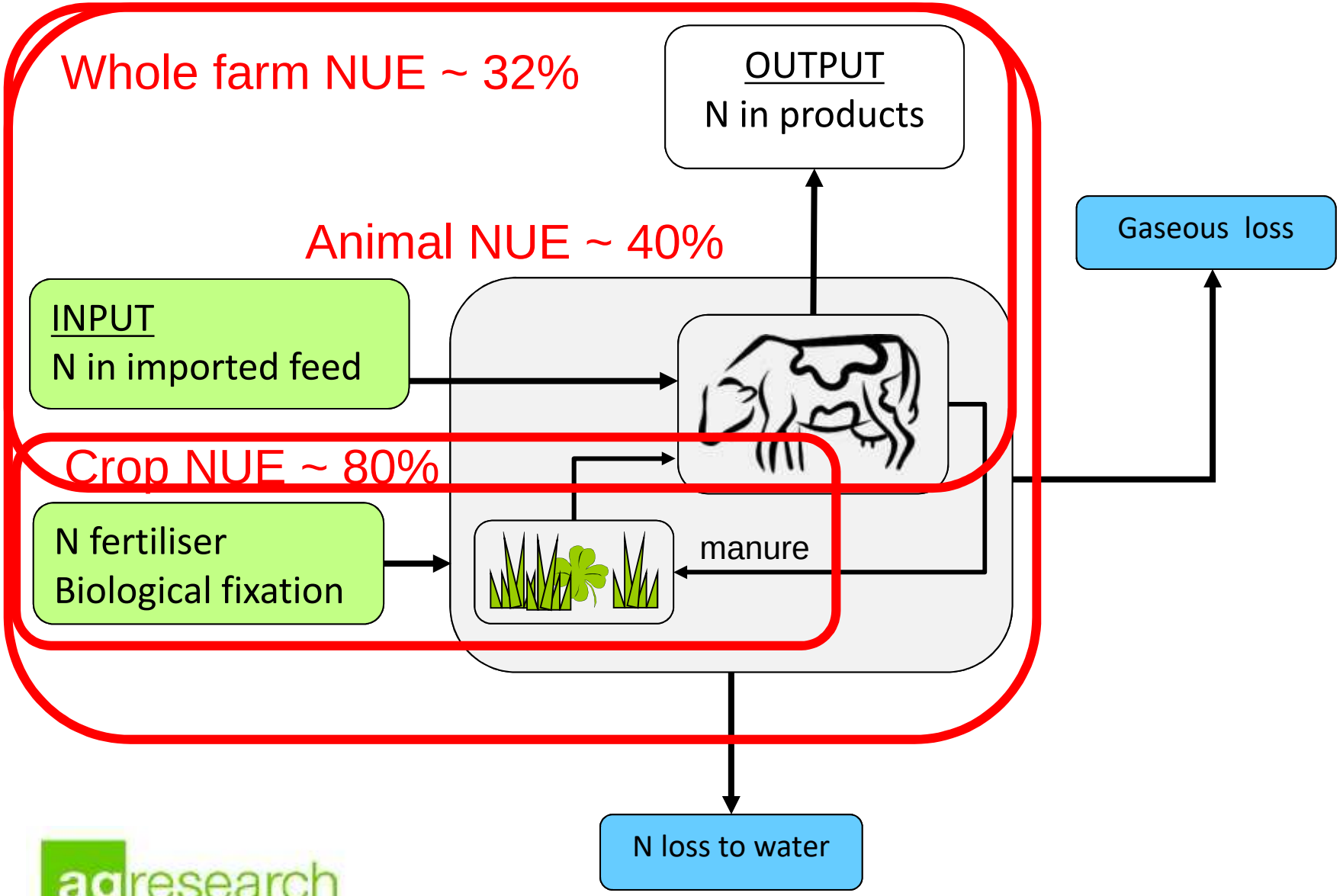
Theoretical limits?



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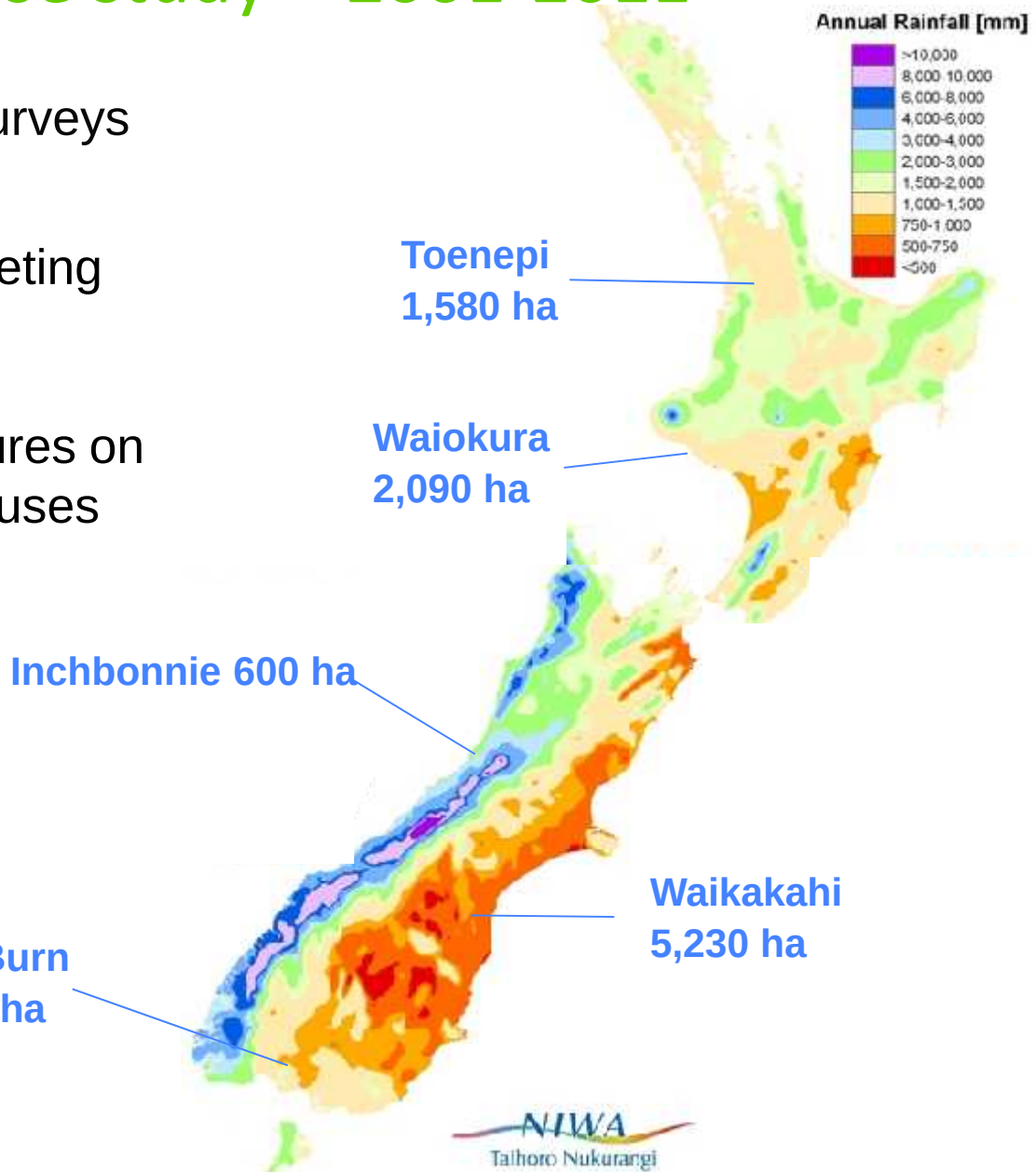
NZ catchments case study – 2001-2011

- 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



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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 Efficiency
	Better quality feed (optimizing protein & ME contents)
Reduce N losses	Nitrification and urease inhibitors Mitigation
	Restricted grazing to avoid urine deposition at high risk times System

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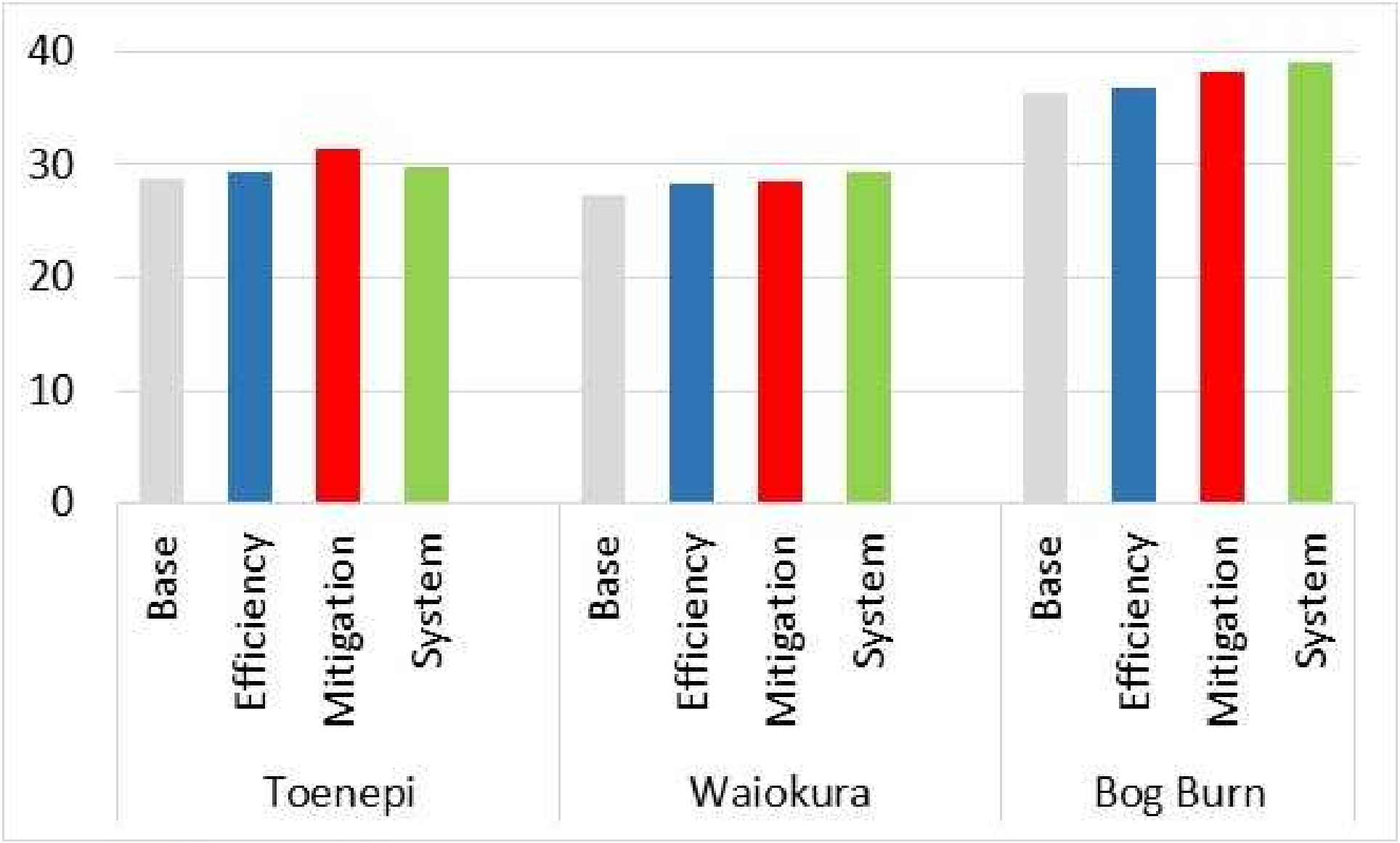
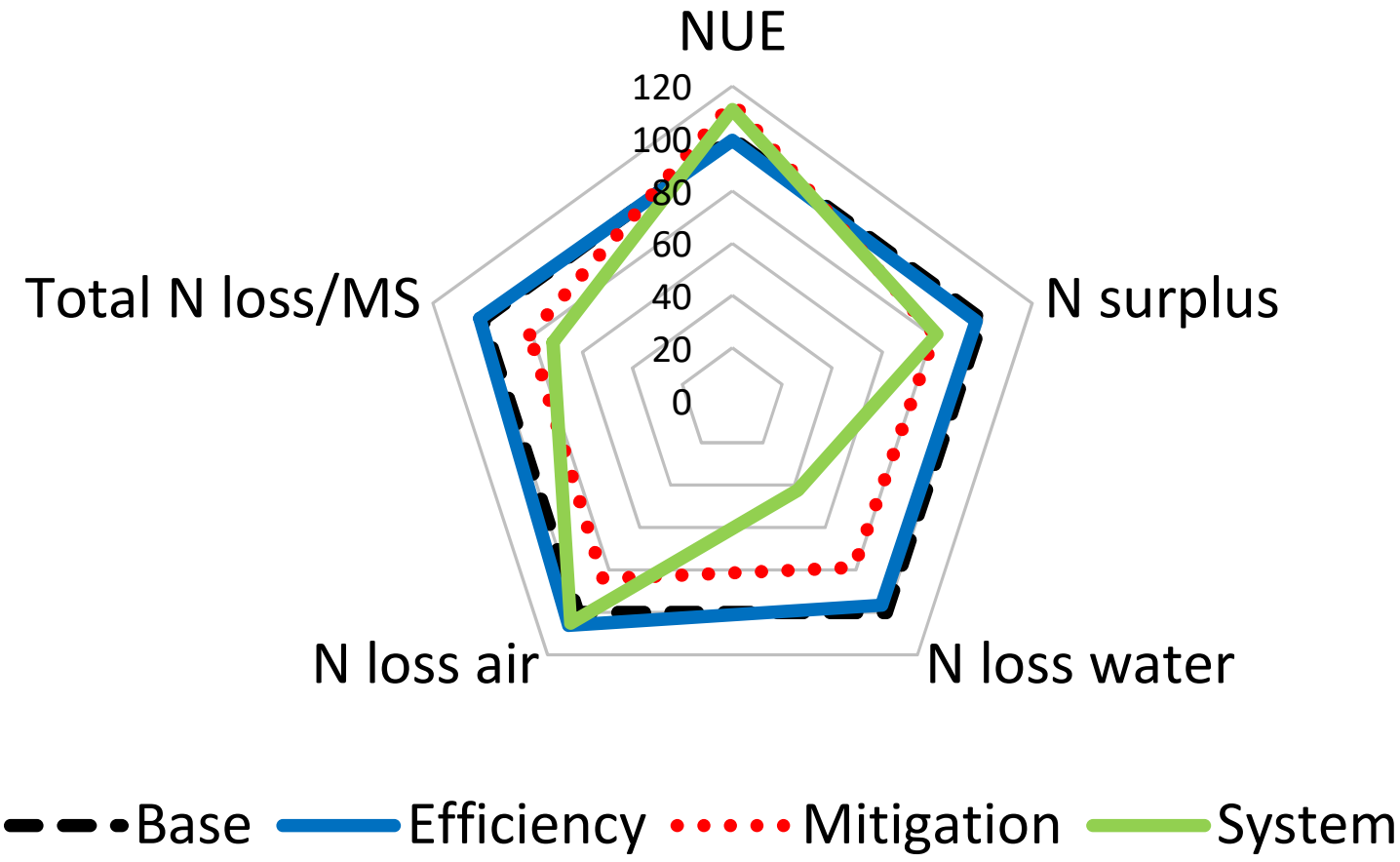
Effect of measures on Whole farm NUE (%)



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



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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

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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?

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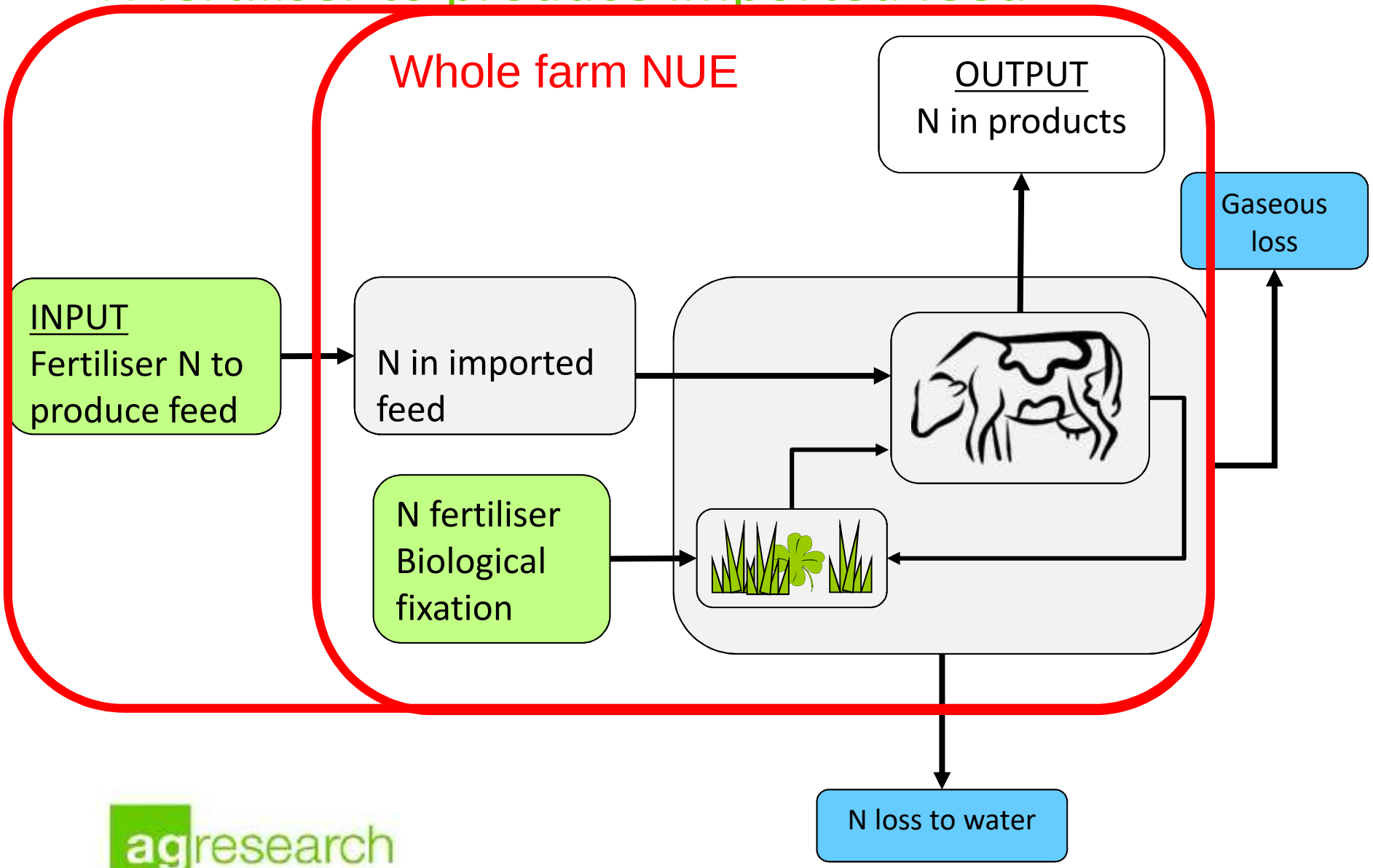
N fertiliser to produce imported feed



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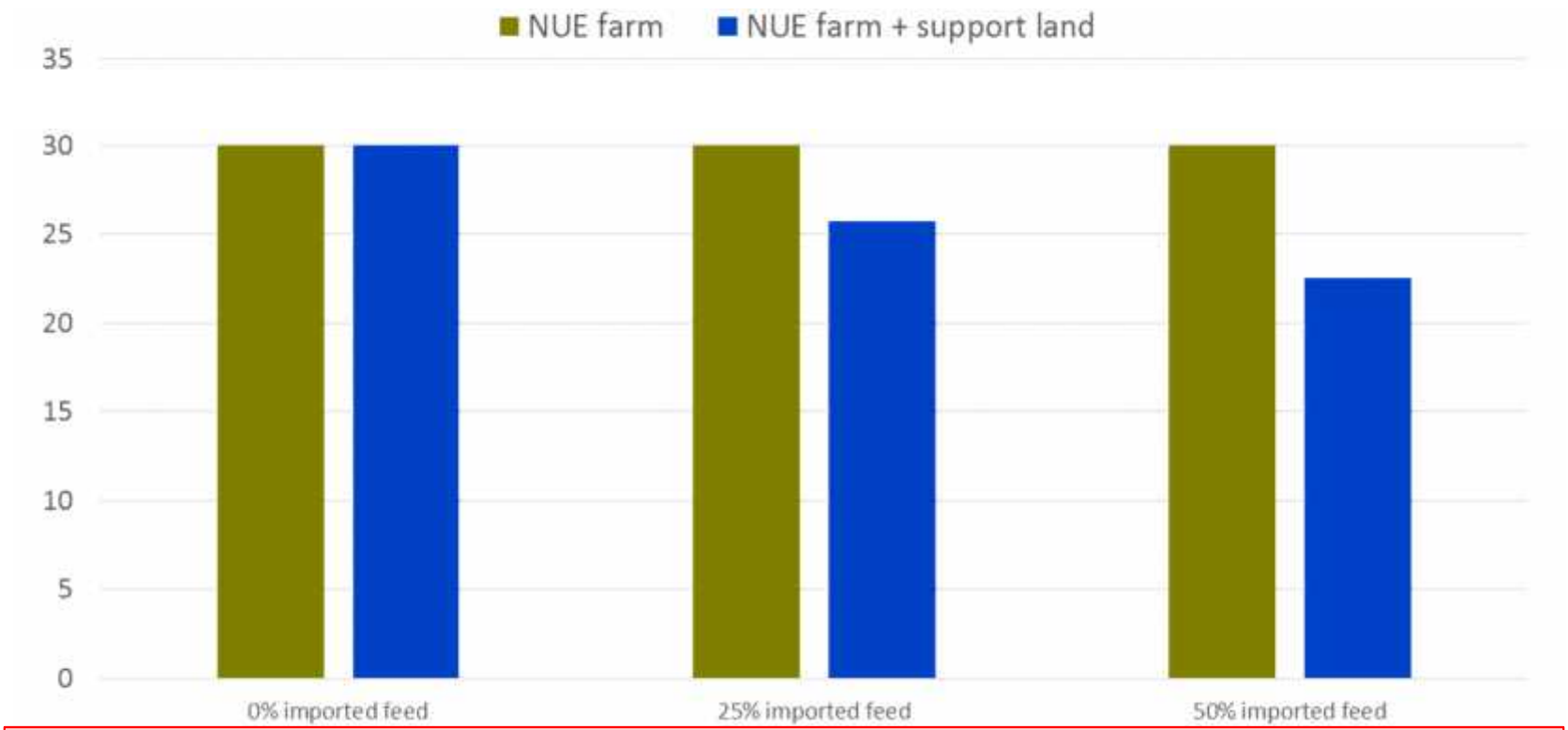
Effect of system boundary on NUE (%)



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%

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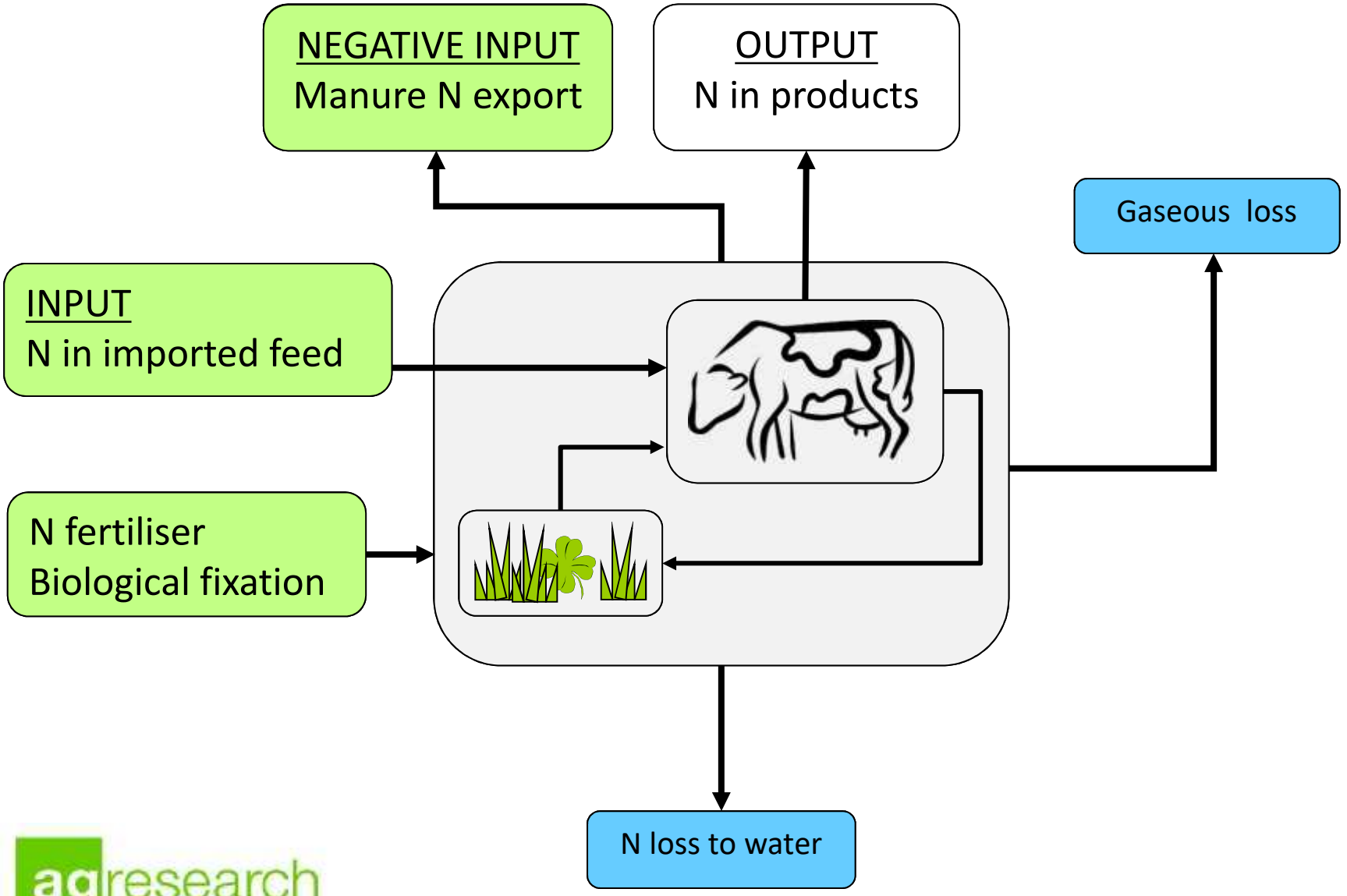
Manure exported off-farm



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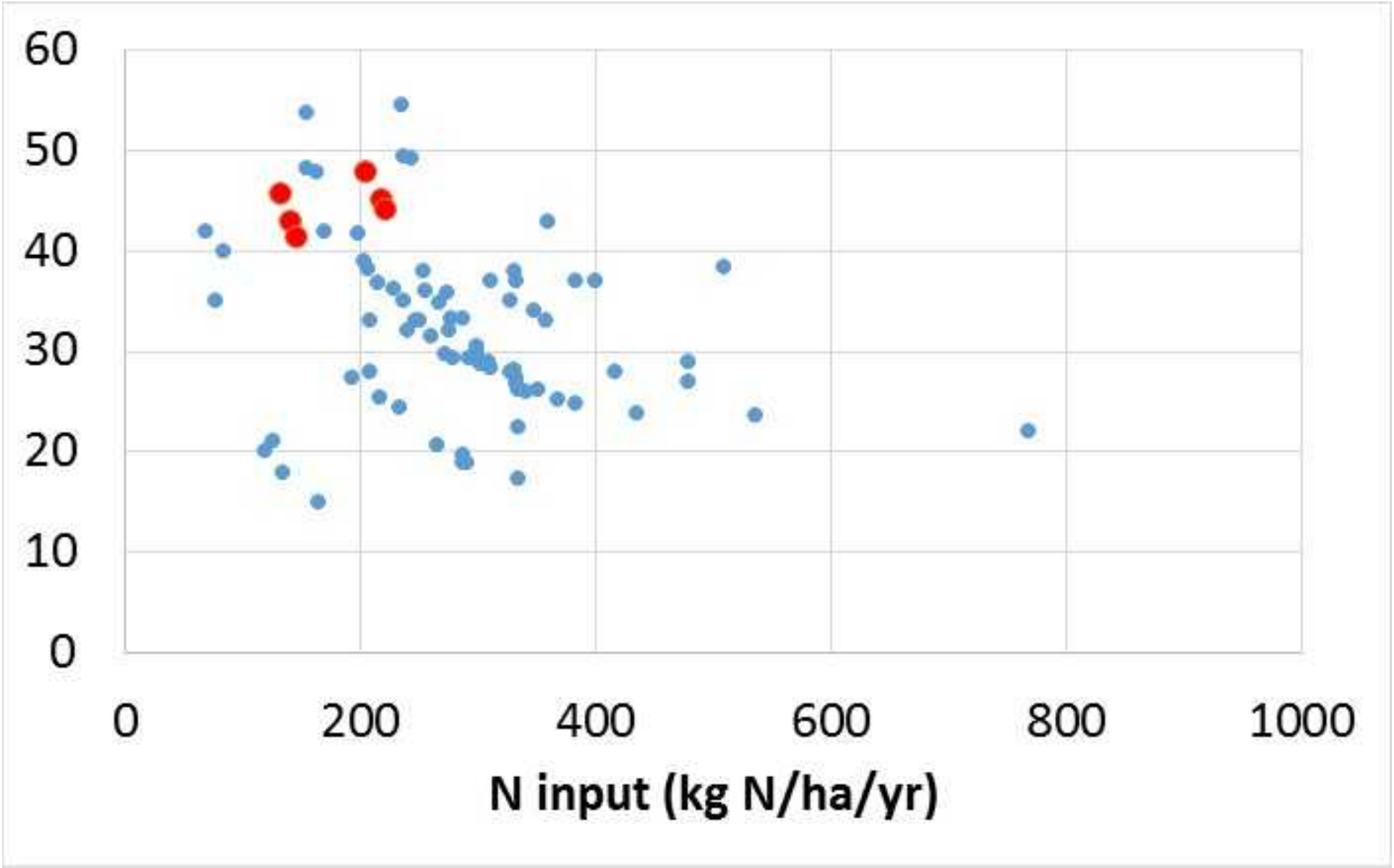
EU Nitrogen Expert Panel, 2016

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

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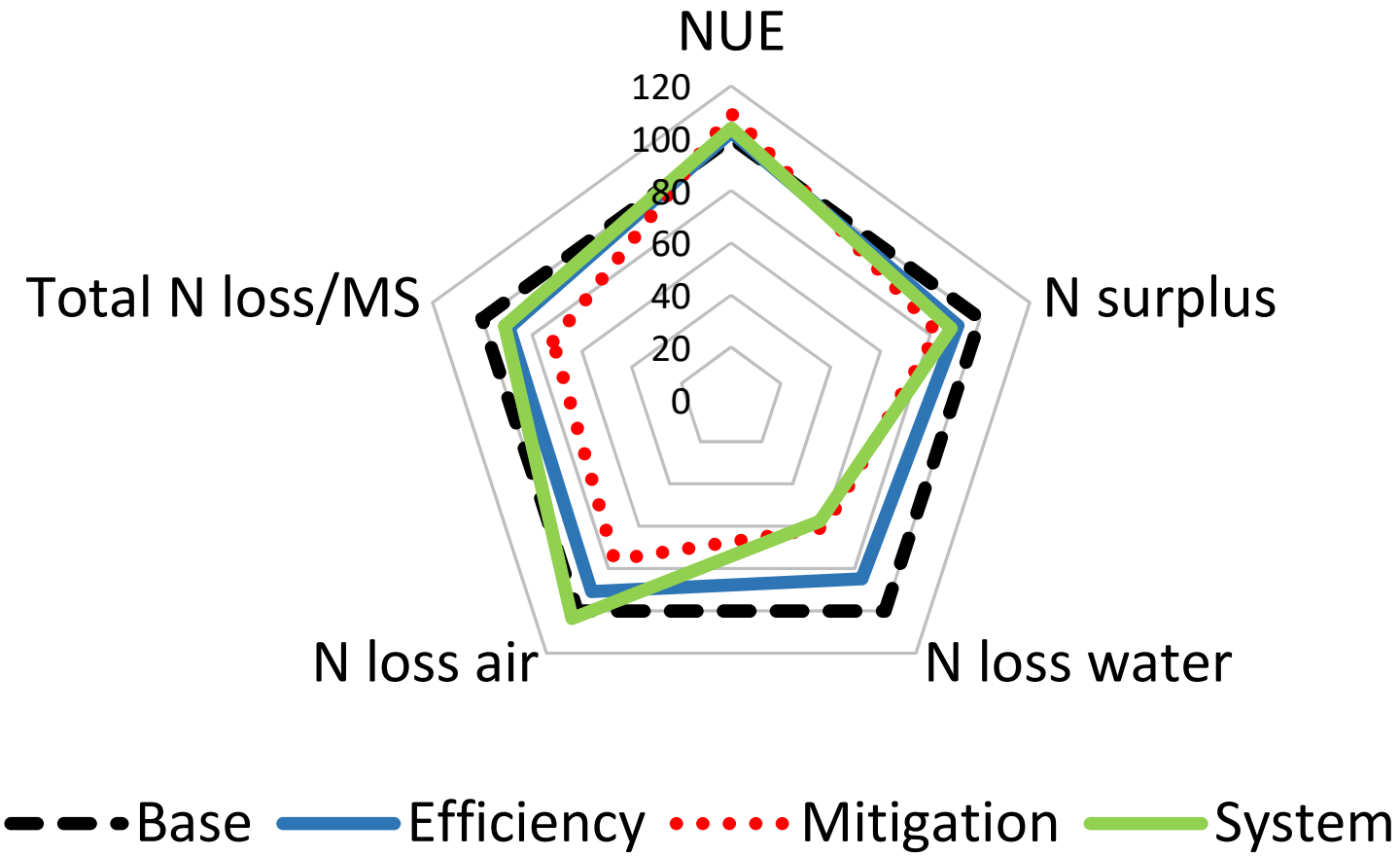
Effect of measures on N metrics relative to Base farm – Toenepi



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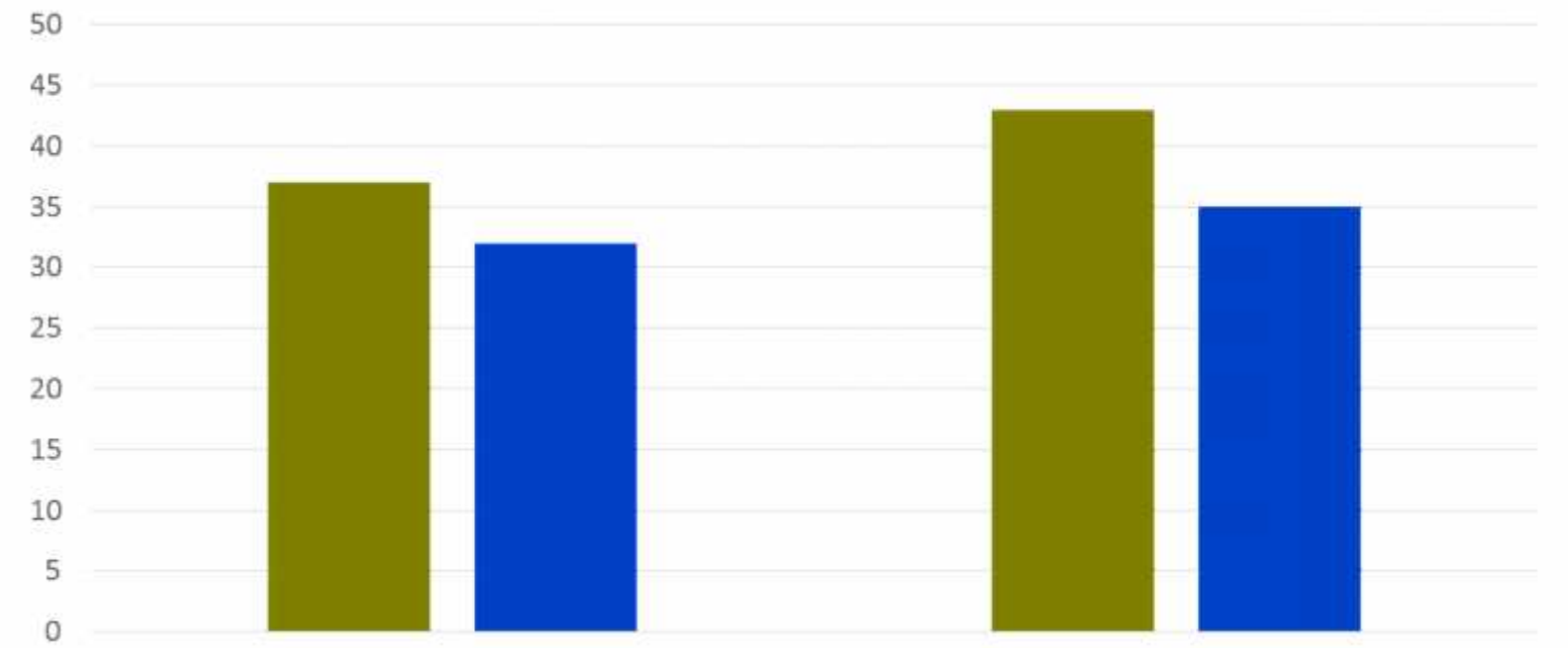
Effect of negative inputs on NUE (%)



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

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