How to reduce environmental impacts from animal manure by more than 50%?

Results of a design and evaluation study on strategies for integrated manure management

Wednesday 17 September 2014, Peter Groot Koerkamp

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Jerke de Vries (PhD student), 17 January 2014

From Animals to Crops – 'Environmental consequences of current and future strategies for manure management

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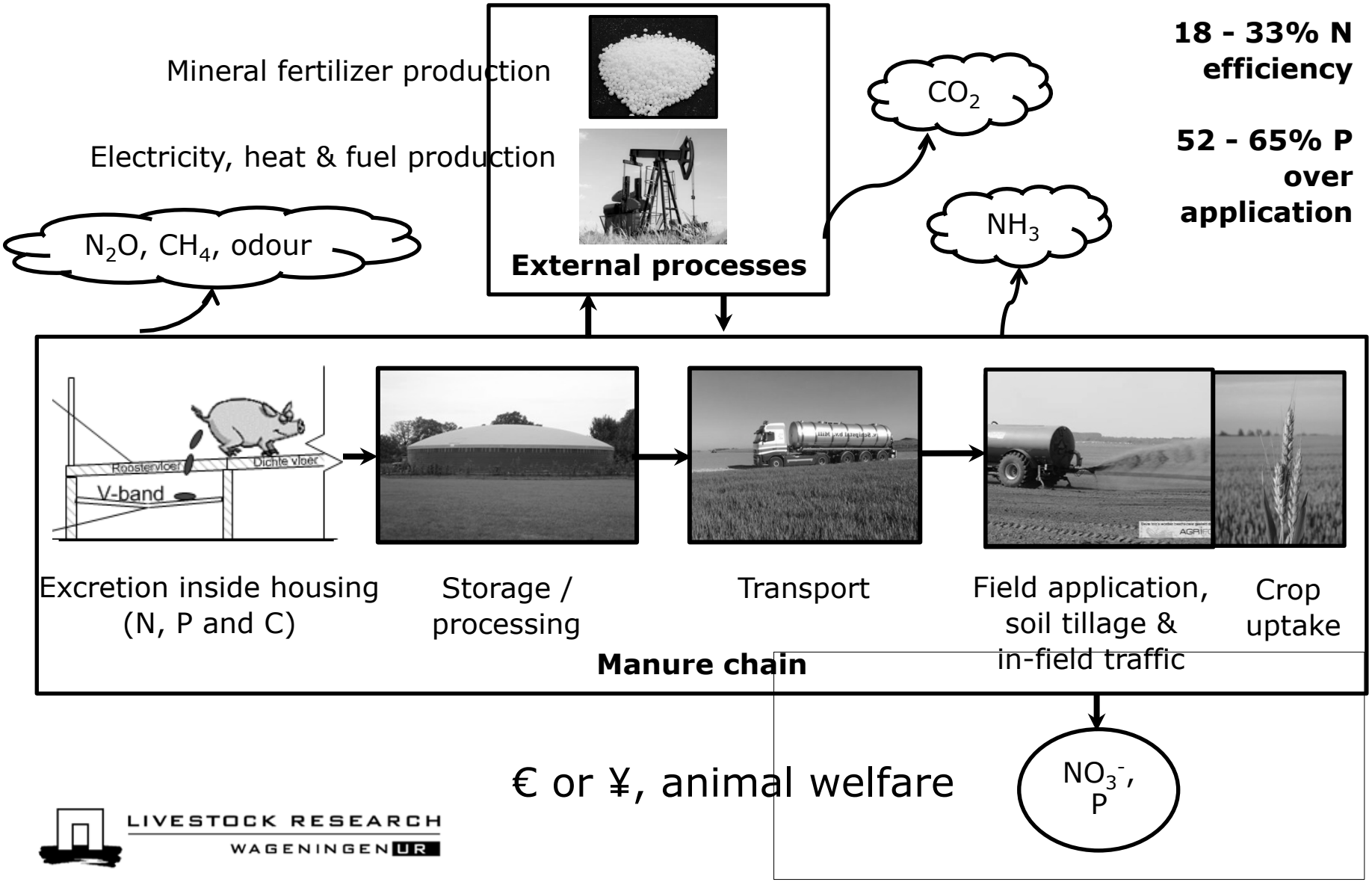
Manure management & environment



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Goal & challenge

Goal

- Reduce environmental impact from manure management by at least 50% for various impacts at the same time
- More than double the N use efficiency

Challenge

- Avoid pollution swapping

Approach

1. Analyse & evaluate current strategies: digestion, high-tech manure processing and segregation
2. Design future strategies
3. Analyse & evaluate future strategies

Methods:

2. Engineering Design (ED) for new manure chains
3. Modelling of losses - Life cycle assessment (LCA) for environmental impact

Engineering Design: involved processes

Production & volatilization of:

1. Ammonia (NH_3)
2. Methane (CH_4)
3. Nitrous oxide (N_2O)
4. Nitrate leaching (NO_3^-)
5. Use of fossil energy
6. Run-off & leaching of nutrients (N & P)
7. Soil carbon depletion
8. Particulate matter formation (from gaseous losses)

Application of Engineering Design

Steps	Example
1. Emission process	▪ Conversion urea ➔ NH_3
2. Process factors involved	▪ Temp., pH, enzyme activity
3. Functions needed	▪ Lower temperature
4. Principle option	▪ Move to cold storage
5. Technical solution	▪ Pumps
6. Interactions	▪ NO_3^- leaching, energy use

Table with 39 lines with processes & involved factors

Selected technical solutions – main effect

- Segregation of pig and dairy cattle urine and feces inside the housing system (CH_4 & NH_3 emission)
- Bio-energy production from feces (fossil electricity/heat)
- Addition of zeolite to solid dairy cattle manure (NH_3)
- Sealed storages (volatilization of N and C)
- Ammonia emission reducing application techniques (NH_3)
- Improved application & tillage management (N_2O, fossil energy, N loss)

Life Cycle Assessment

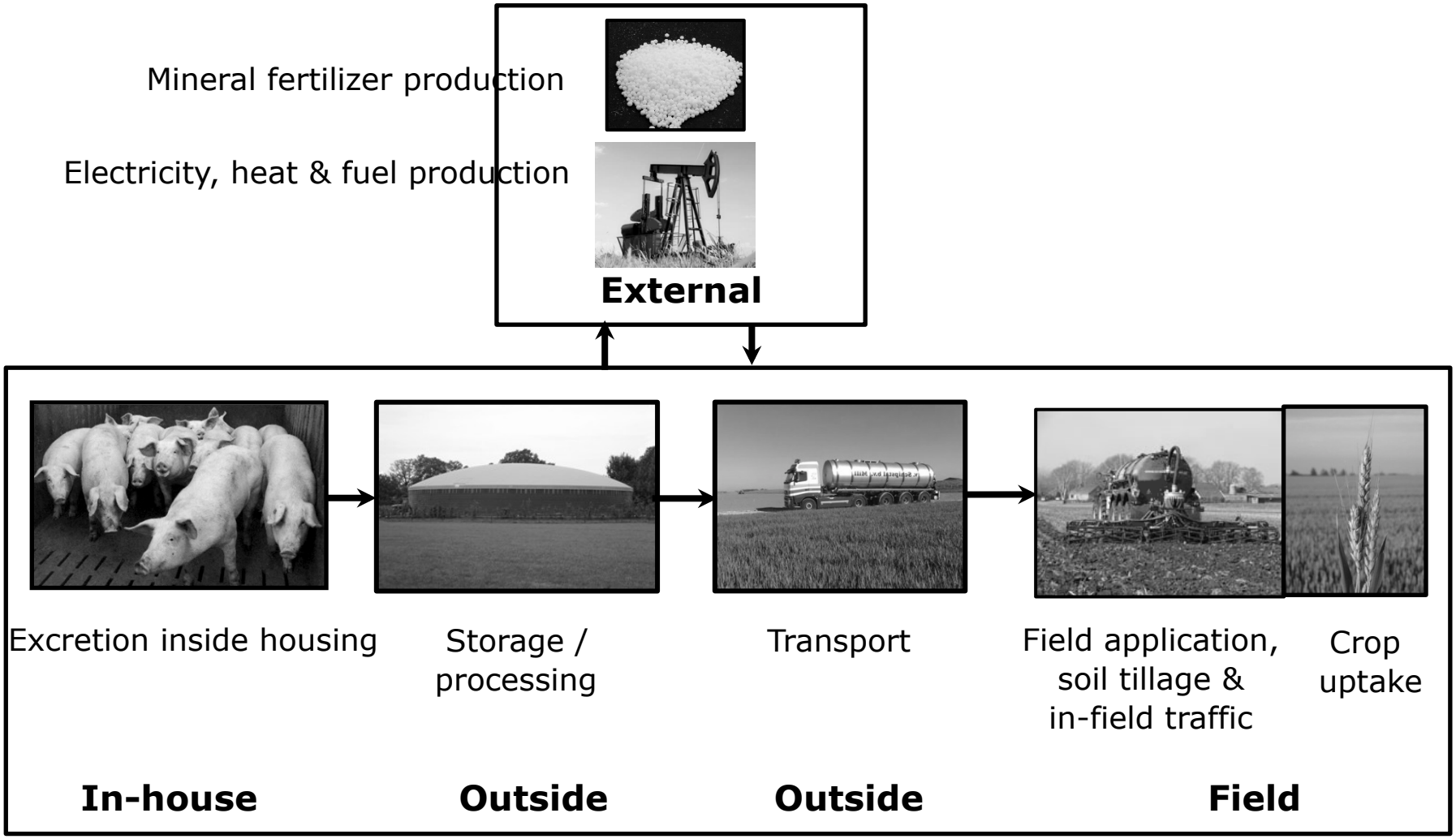
4 representative crop-manure combinations in NW-Europe:

- Gras – liquid cattle manure
- Gras - solid cattle manure
- Maize – liquid cattle manure
- Wheat – liquid pig manure

- Reference: house with slats & storage, no storage covers, broadcast spreading, plowing, random traffic
- Monte-Carlo uncertainty analysis on loss coefficients
- Effects: Climate Change, Terrestrial Acidification, NUE

Results: environmental evaluation

Manure management & environment



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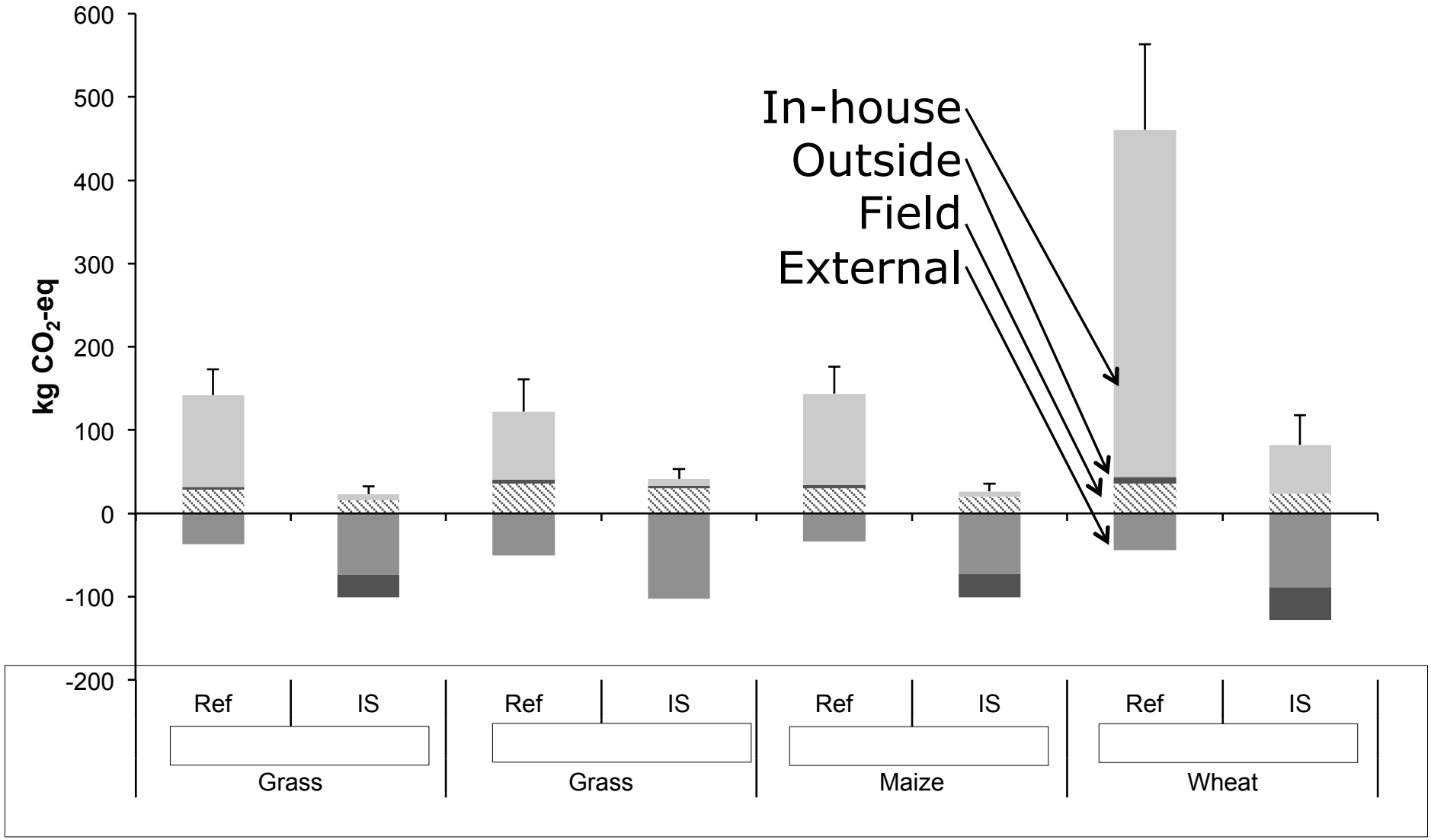
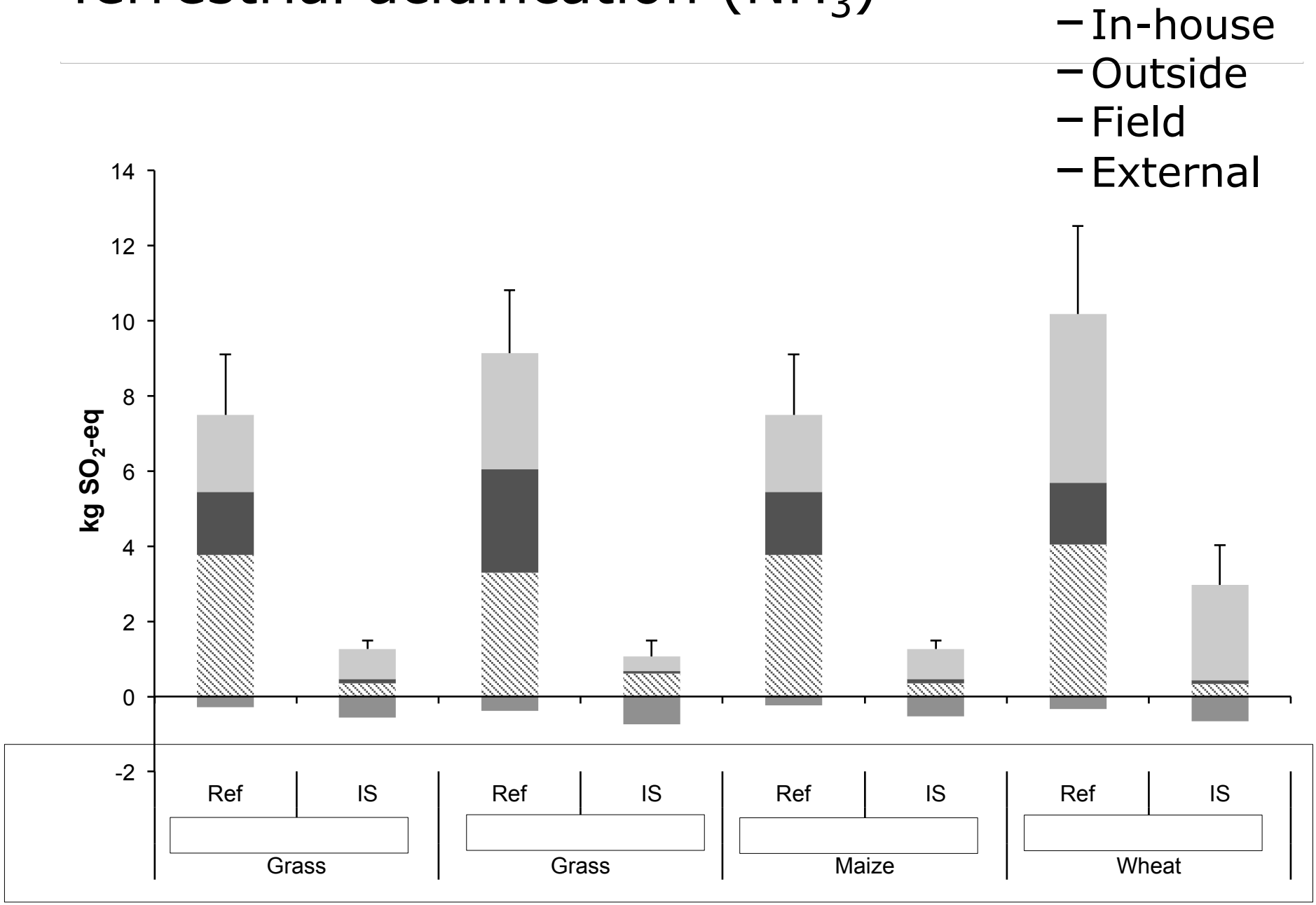
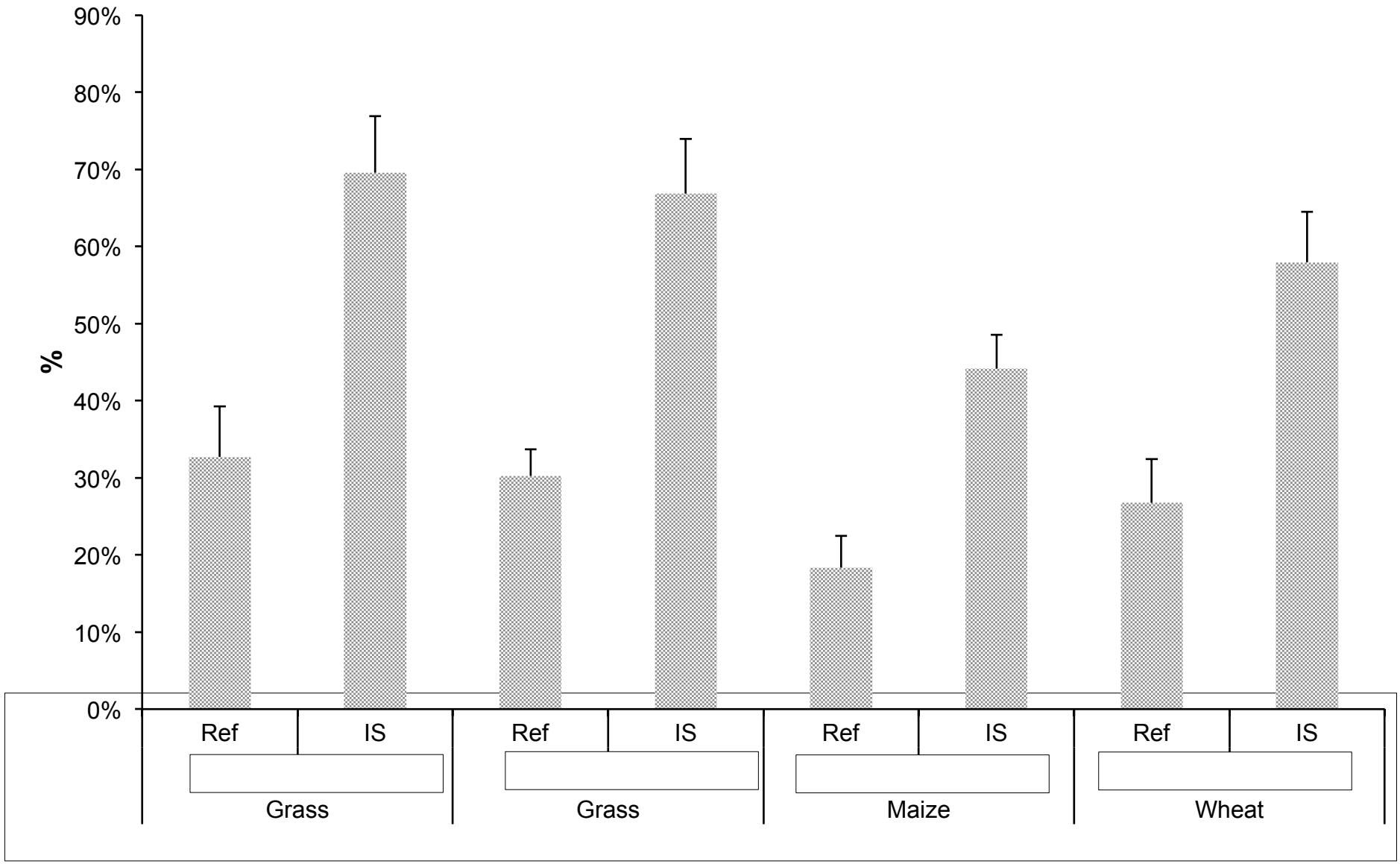
Climate change (CO_2, N_2O and CH_4)



Terrestrial acidification (NH_3)



Nitrogen Use Efficiency (crop-excreted)



Discussion & conclusion

- Adapted design methodology proved to be effective
- Successful in doubling N-use efficiency and prevention of polluting swapping: reduction >50% on all impacts
- Validate model results of emissions: lab & field
- Economic consequences

Further reading

- De Vries, J.W., W.B. Hoogmoed, K.M. Groenestein, J.J. Schröder, W. Sukkel, I.J. De Boer, P.W.G. Groot Koerkamp, 2014.
  Integrated manure management to reduce environmental impact: I. Structured design of strategies.
  Accepted for publication in Agricultural Systems
- De Vries, J.W., W.B. Hoogmoed, K.M. Groenestein, J.J. Schröder, W. Sukkel, I.J. De Boer, P.W.G. Groot Koerkamp, 2014.
  Integrated manure management to reduce environmental impact: II. Environmental impact assessment of strategies.
  Accepted for publication in Agricultural Systems

End

Segregation of
faeces and urine
of pigs
by a manure belt
under a slatted floor

谢谢

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