A life cycle assessment of seasonal grass-based and confinement dairy farms

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Background

- Irish dairy producers mainly grass-based
- Post milk quota abolition production expected to grow
  - Government target to increase milk output by 50% by 2020
- Land availability will be new constraint
- Expansion in confinement dairy systems expected
- How will this impact the environment?

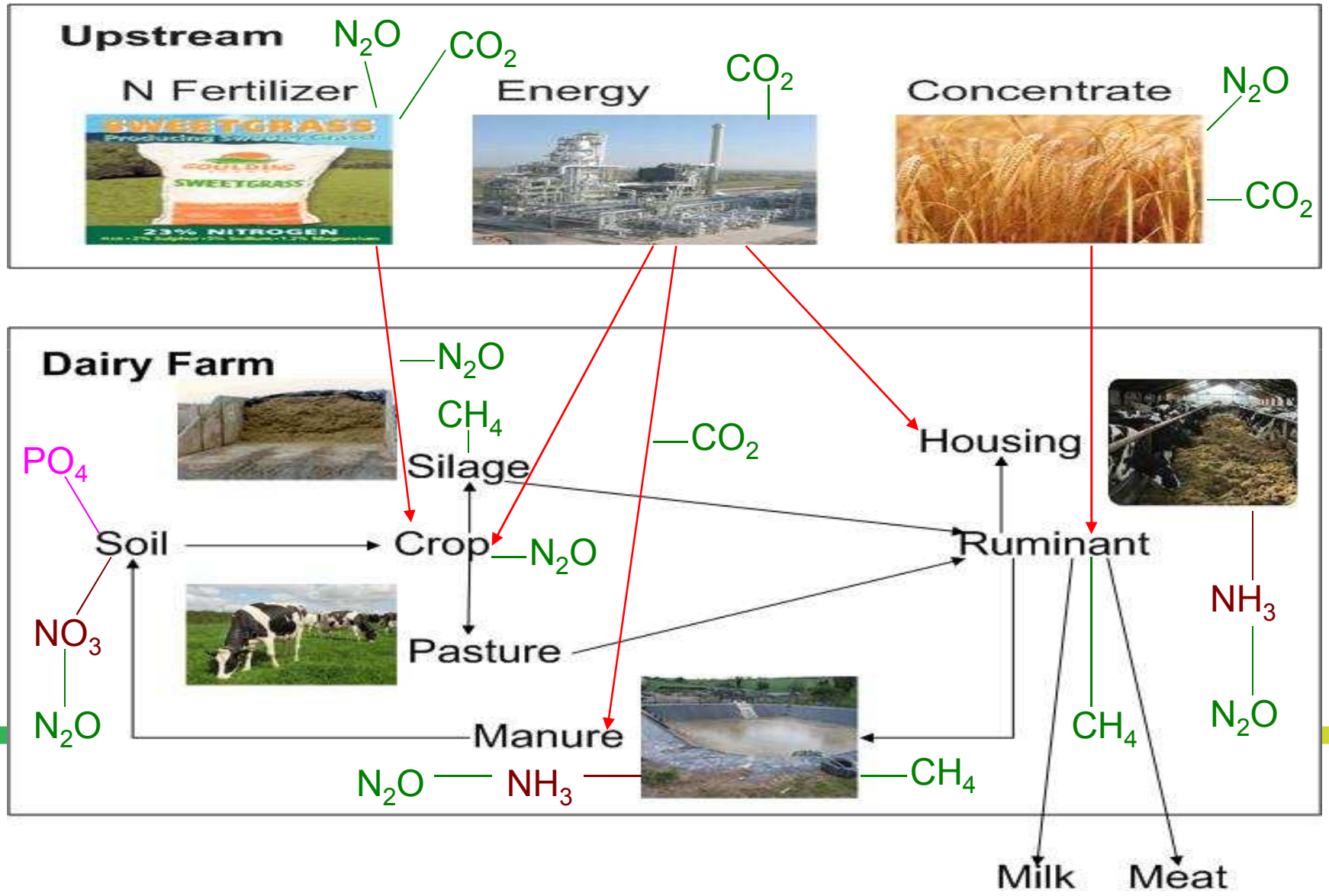
Aim of study

- Primary objective to develop a life cycle assessment model (LCA) to analyse the environmental impact of a seasonal calving-grass based dairy system and a confinement dairy system
- Study confined to two research farms
  - Data intensive
  - On-farm emission measurements

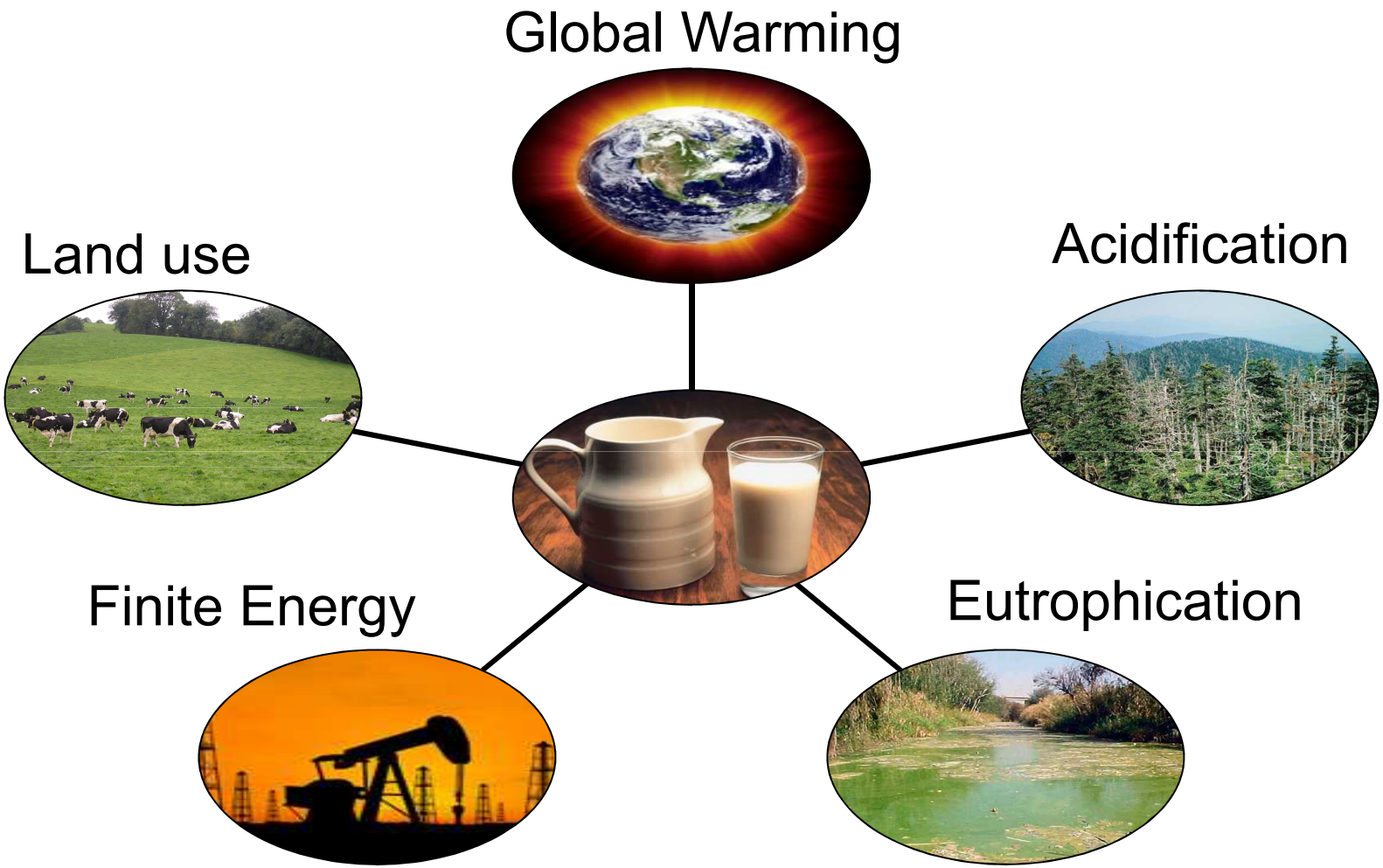
Farm data

Item	Grass	Confinement
Farm size	40	20
# Friesian cows	90	90
kg FPCM/cow	6,639	8,040
Replacement rate	18	18
Grass, kg/cow	4,093	-
Silage, kg/cow	1,063	3,742
Concentrate, kg/cow	370	2,865
N fertiliser, kg ha	260	85

System Boundaries



Environmental Impacts



Functional unit

- Environmental impacts assessed per unit of product and per unit area
  - per kg of fat and protein corrected milk (FPCM; 4% fat and 3.3% protein)
  - per ha of land occupied

Allocation

- Dairy systems produce and consume co-products
  - Milk, culls and surplus calves
  - Feed by-products e.g. corn gluten
- Impacts were allocated between co-products
  - Biological basis – Milk and meat
  - Economic basis – concentrate co-products

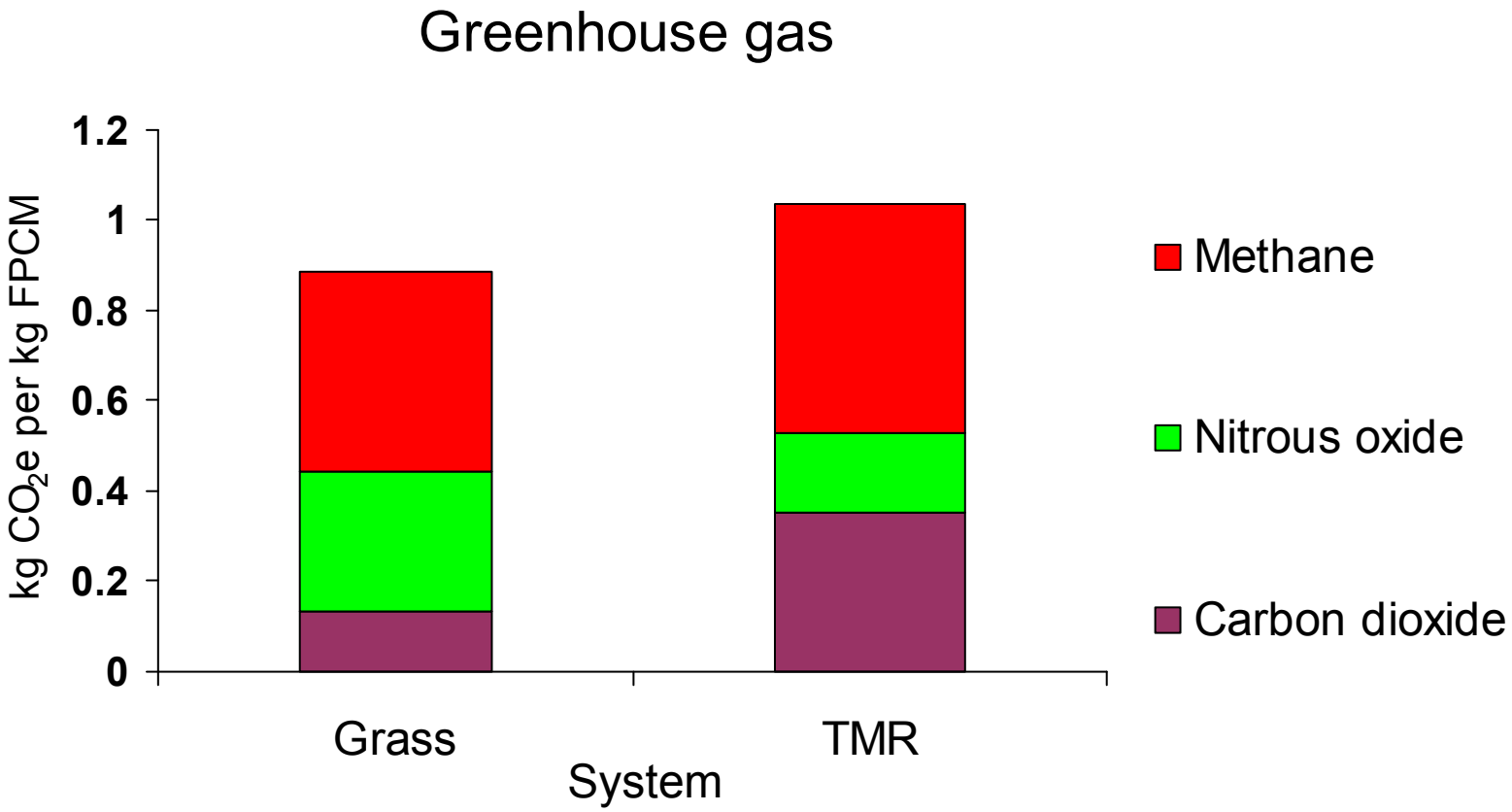
Inventory analysis

- Resource use recorded on-farm e.g. finite energy use
- Average yields applied to estimate area required for purchased feed
- On-farm emissions quantified using published algorithms and on-farm measurements
- Off-farm emissions Ecoinvent database/literature

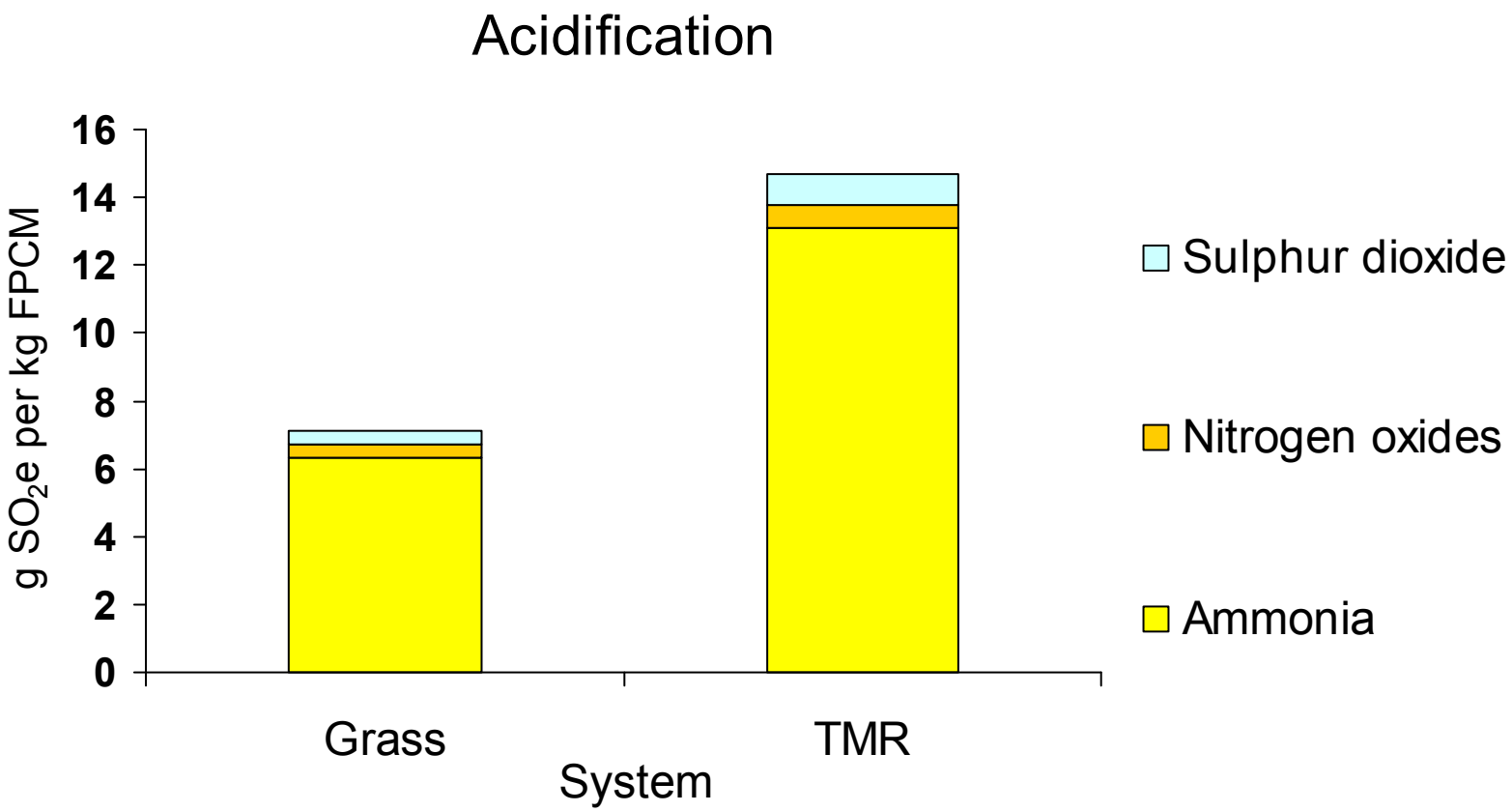
Impact assessment

- Emissions converted into environmental impacts
- Greenhouse gas emissions → CO_2 equivalent
  - CO_2 = 1; CH_4 = 21; N_2O = 310
- Acidifying emissions → SO_2 equivalents
  - SO_2 = 1.2; NH_3 = 1.6; NO_x = 0.5
- Eutrophic emissions → PO_4 equivalents
  - PO_4 = 1; NO_3 = 0.1; NH_3 = 0.35; NO_x = 0.13

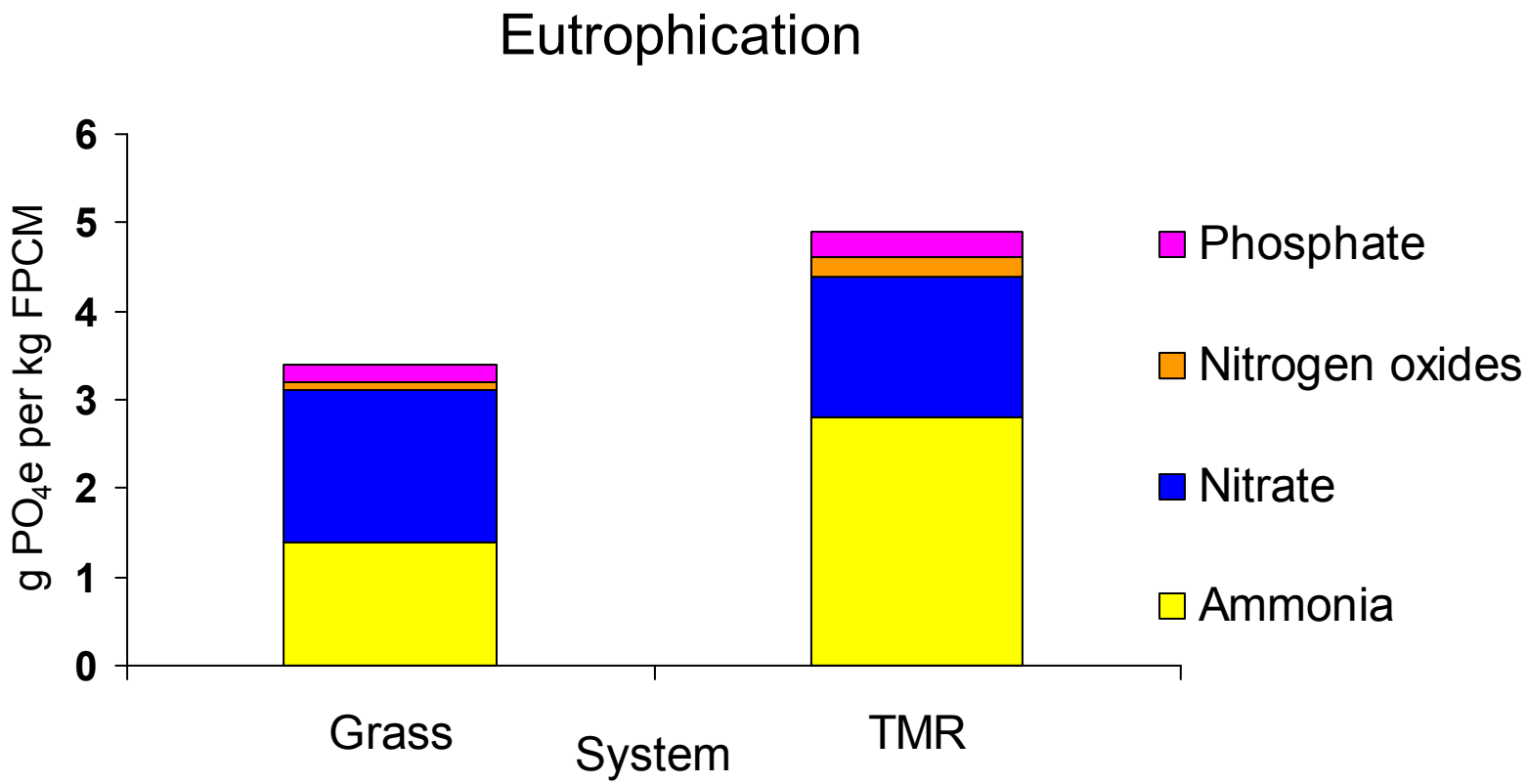
LCA model results



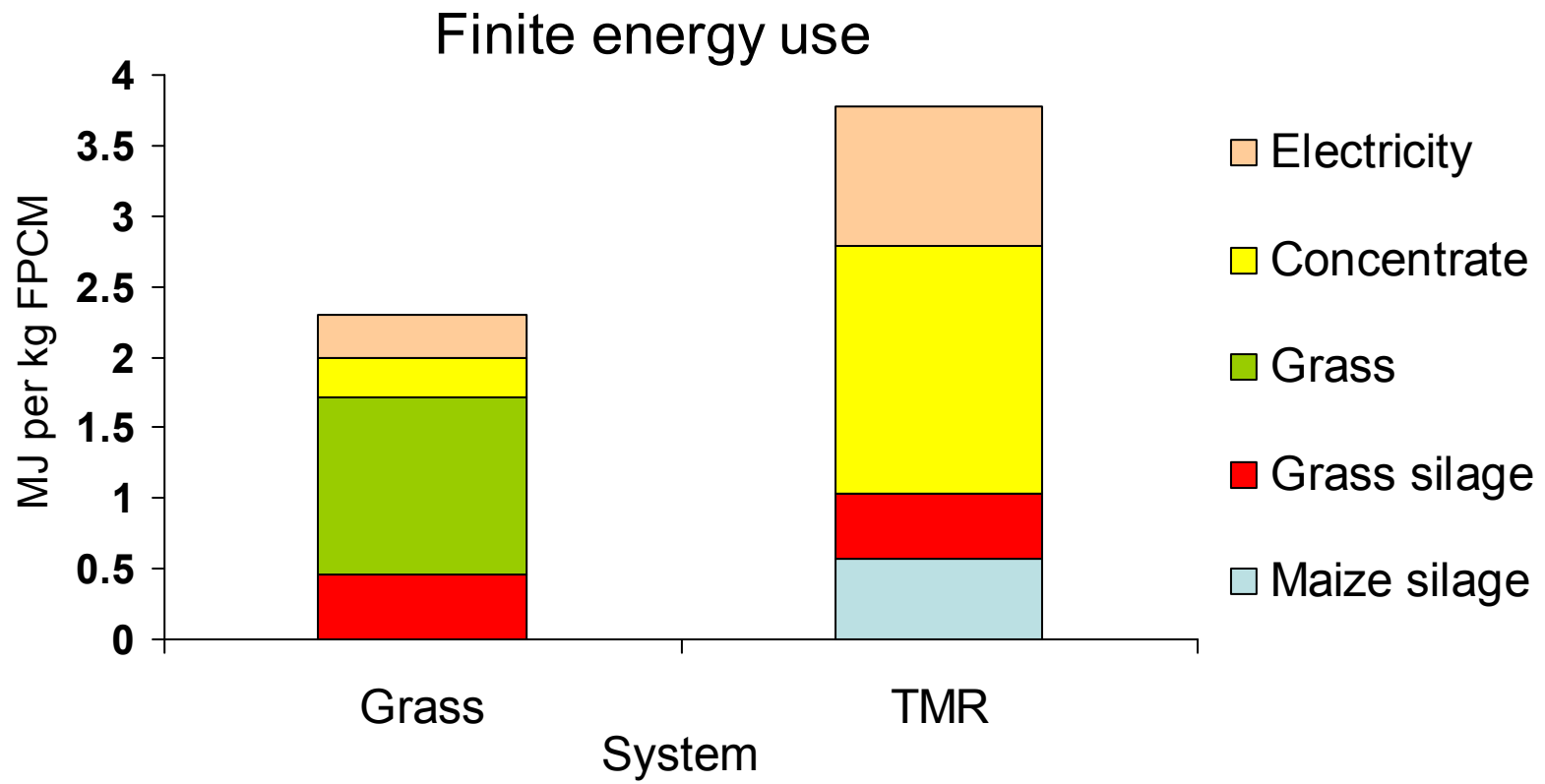
LCA model results



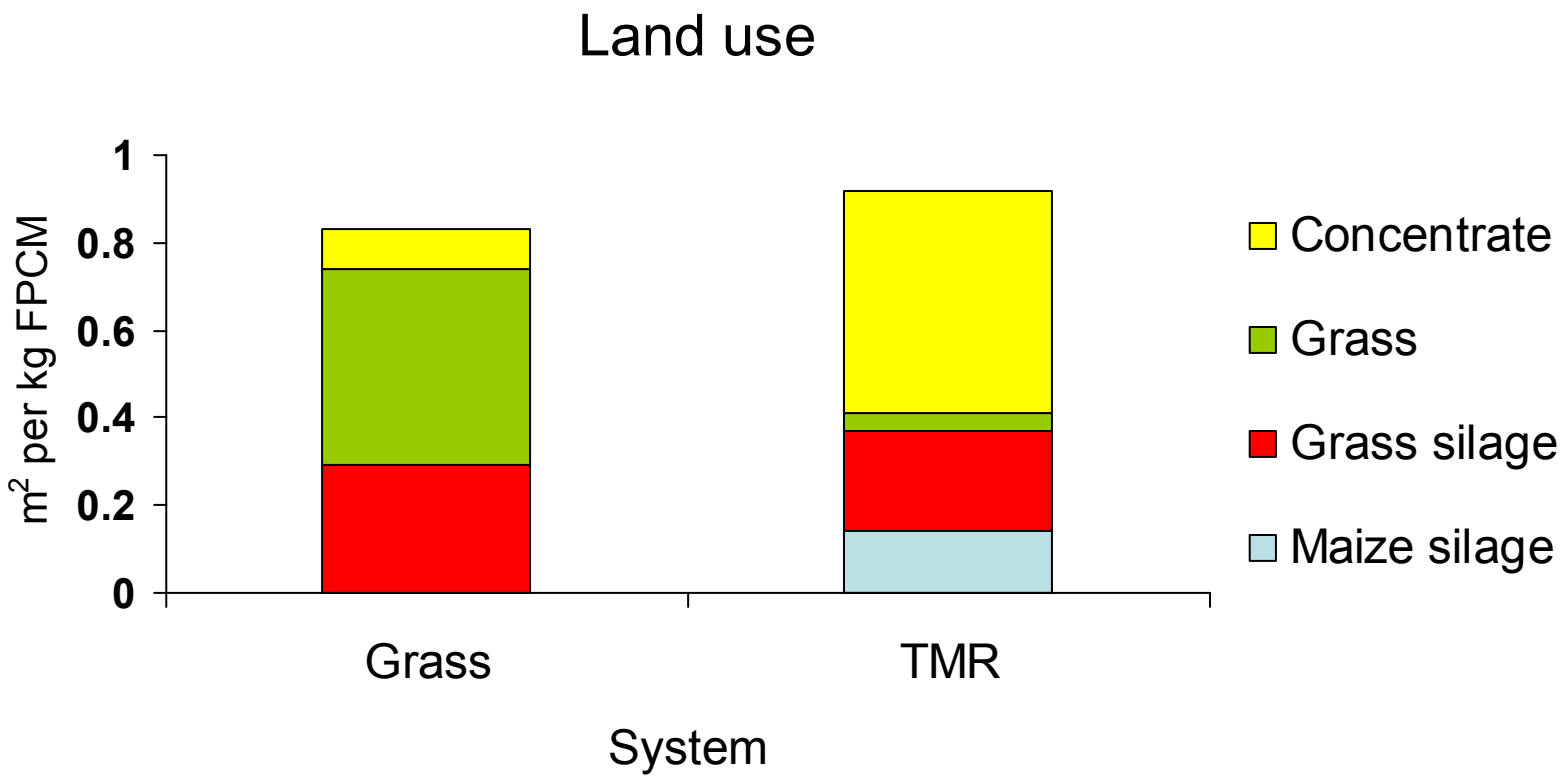
LCA model results



LCA model results



LCA model results



LCA model results

Impact per total ha	Grass	Confinement
Finite energy use, GJ	31	42
Global warming, t CO_2e	12	11
Acidification, kg SO_2e	98	157
Eutrophication, kg PO_4	46	52

Scenario analysis

- Allocation decisions
  - Economic allocation – milk and meat
  - Mass allocation – concentrate co-products
- Mitigation options
  - Concentrate feed type and origin
  - Manure treatment
  - Reduce N surplus

Conclusions

- Grass-based system require less resources and emitted less emissions per kg of FPCM
- Potential to improve both systems
  - Concentrate composition and use
  - N efficiency
  - Manure management
- Further LCA harmonisation required


Thank you