A comparison of greenhouse gas (GHG) emissions from dairy farms by four systems models with eight agro-climatic scenarios

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The Four Models

- **SFARMMOD**, Cranfield University, UK
  optimised management; emission factors
- **DairyWise**, Wageningen University, The Netherlands
  optimised feeding; empirical emission factors
- **FarmAC**, Aarhus University, Denmark
  user inputs management; emission factors (except dynamic soil model)
- **HolosNor**, Norwegian University of Life Sciences
  user inputs management; emission factors




Eight (2^3)
Agro-climatic scenarios
Results 100 year CO_2 Equivalents

Cranfield UNIVERSITY

Climate	Soil type	Cropping
1. Cool: Netherlands	1. Light: Sandy	1. Grass
2. Warm: Northern Spain	2. Heavy: Clayey	2. Grass and Forage Maize

1x CO_2

25x CH_4

298x N_2O

Scenario key data

Dairy cows + followers (1:1)

600 kg LW & 7000 kg ECM/cow/yr

Cool climate grazing 5 months
Warm climate grazing 10 months
16 hours/day grazing

Minimum use of concentrates
No manure import/export

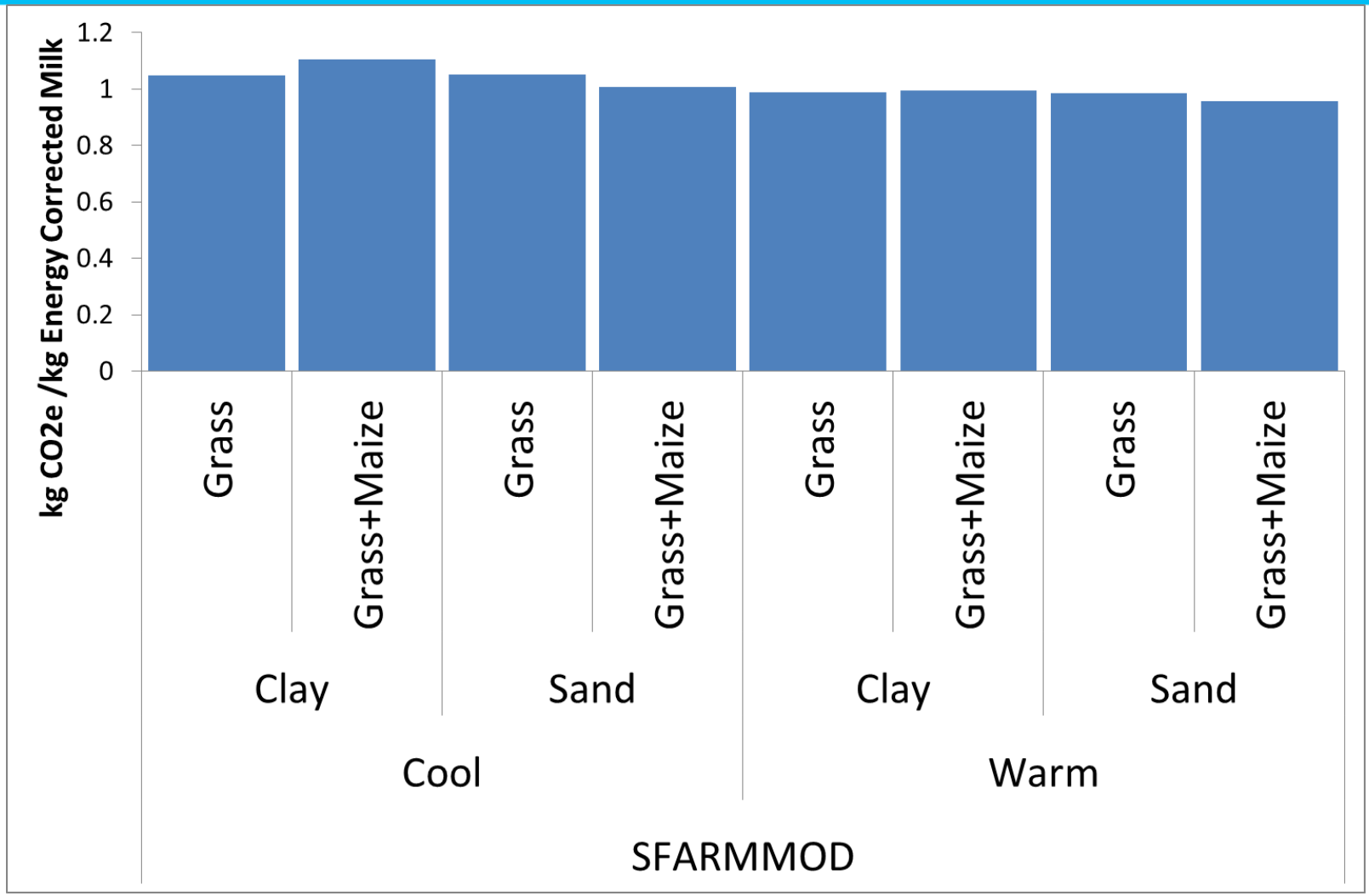
Plant-available N:
Grass 275 kg/ha/yr
Maize 150 kg/ha/yr
(Manure broadcast)

For each scenario, adjust cow numbers to match feed supply

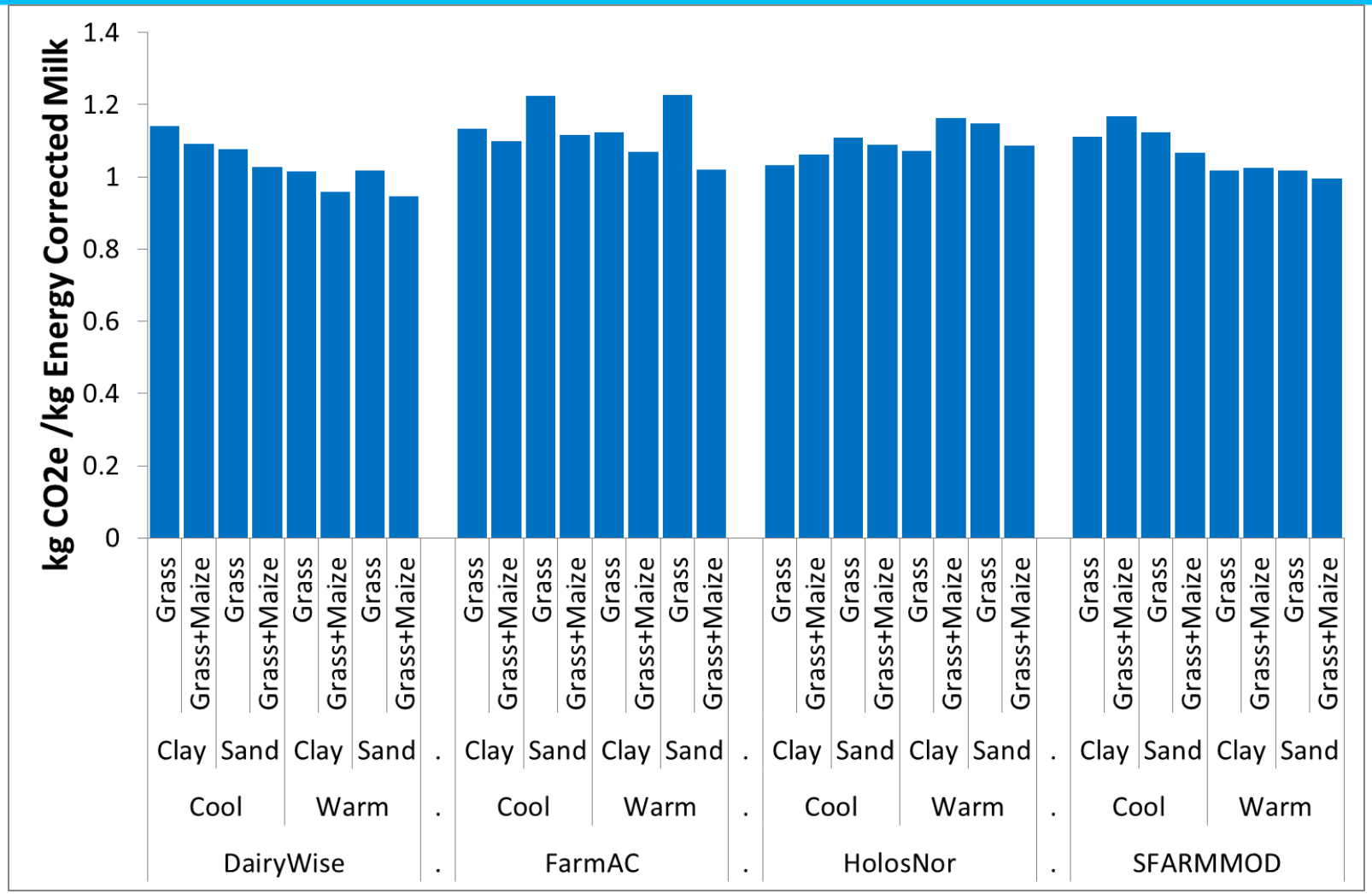
Key Points of this talk

1. Overall the models are in good agreement
2. They vary in the detail
3. There are wider experiences and recommendations to share

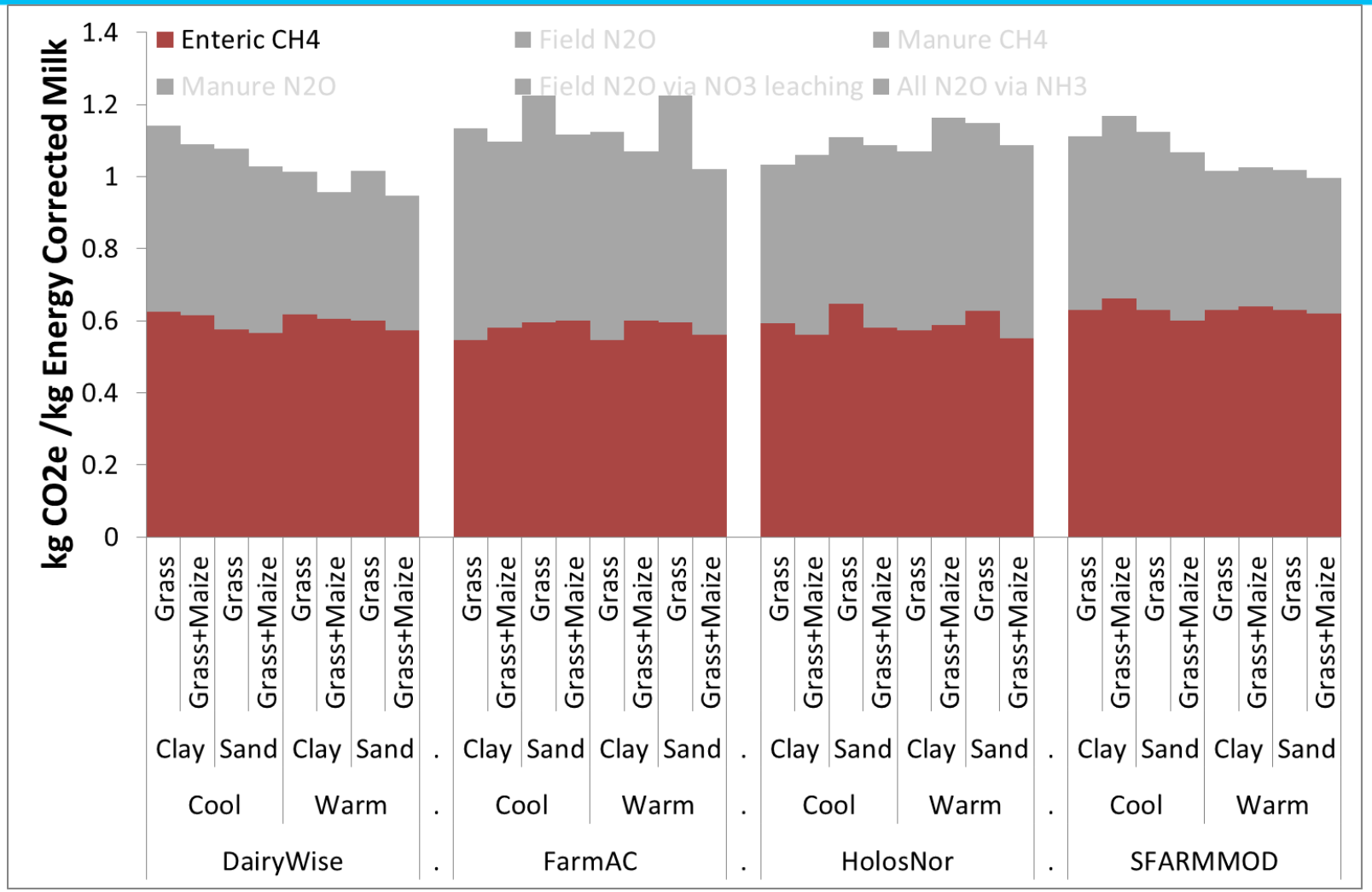
Key to Results charts



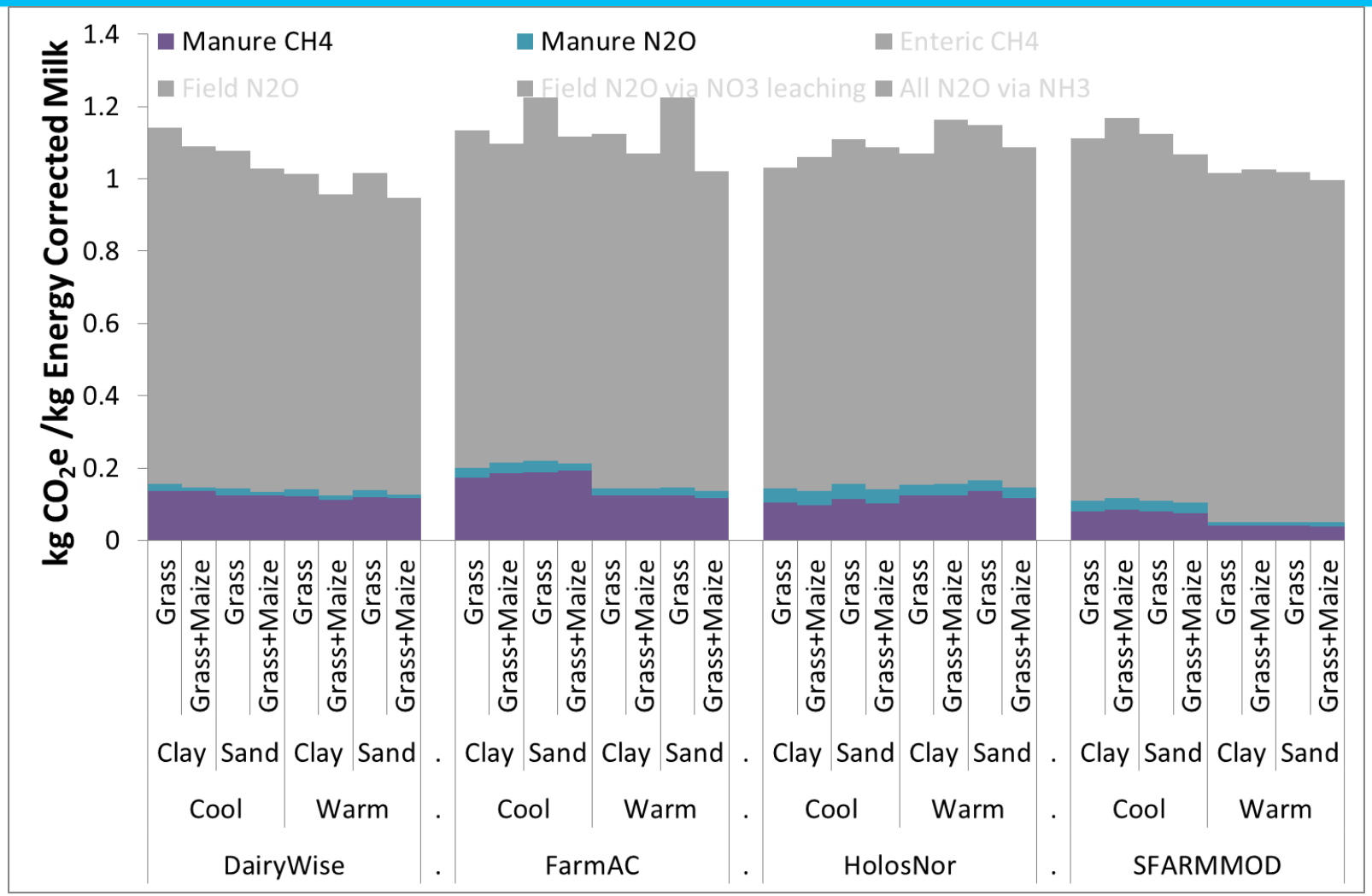
Total per kg Milk



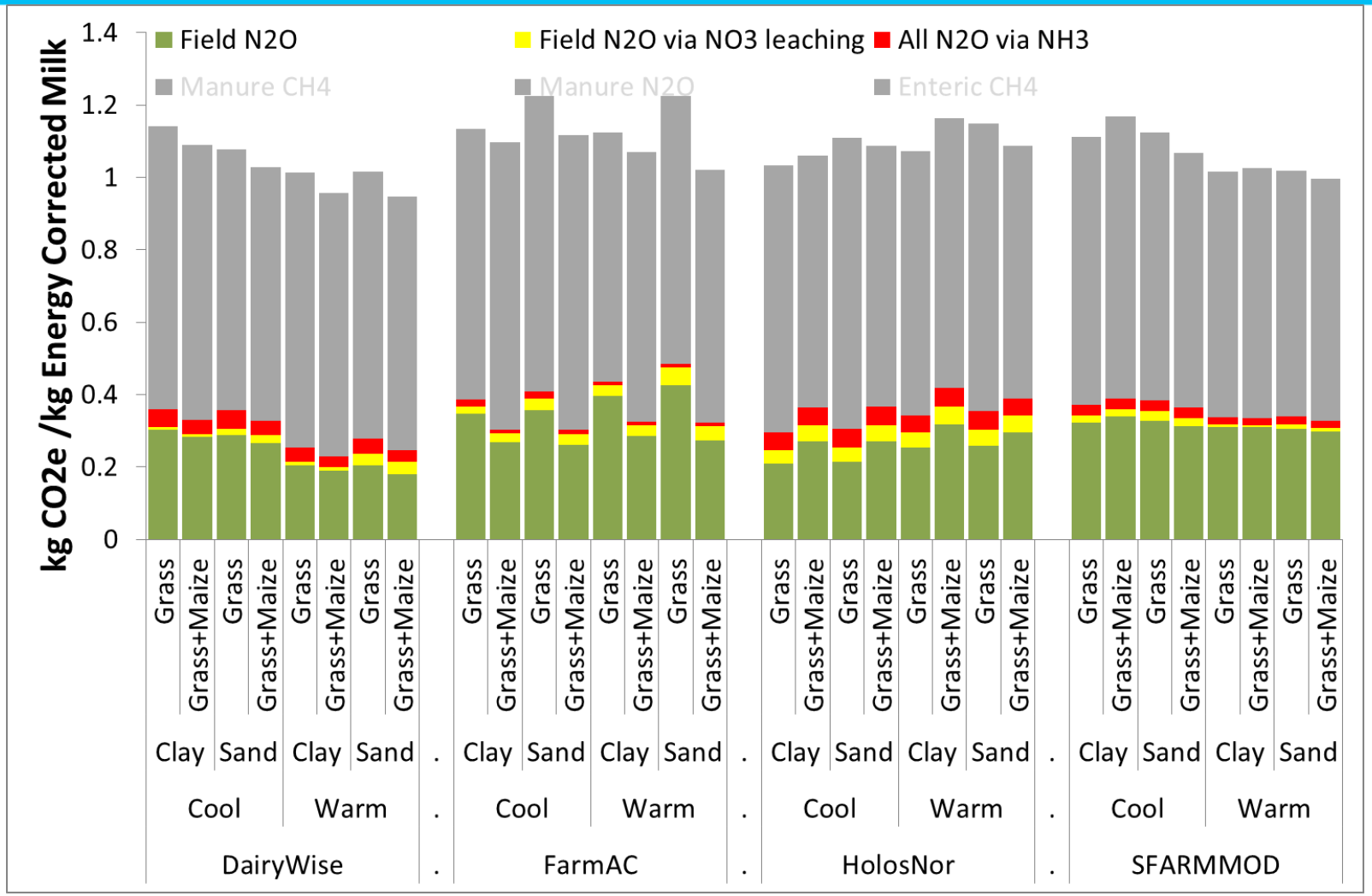
Enteric


kg CO2e /kg Energy Corrected Milk
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Enteric CH4
Field N2O
Manure CH4
Manure N2O
Field N2O via NO3 leaching
All N2O via NH3
Grass
Grass+Maize
Clay
Sand
Cool
Warm
DairyWise
FarmAC
HolosNor
SFARMMOD

Manure management



Field and indirect N_2O



Discussion & experiences

- The scenarios only make small differences to the Total
  - Farm-gate not Life-Cycle GHG emissions e.g. not the manufacture of fertilisers, etc
- No new comparisons to measurements
- Not all management factors can or were controlled e.g. area of maize, etc (See aside 1).
- Hard work e.g. assumptions and ambiguities and novel regions and data (See aside 2)
- Ensemble Modelling? (See aside 3)

Take-away points

1. Good general agreement across models, but differences in detail
2. Key carbon footprint is: Enteric CH_4, Field N_2O and Manure CH_4
3. Ensemble modelling offers the next step beyond model comparison
4. Challenge the sixth sense when looking at unfamiliar regions and data.
5. Communication is key and takes work

Acknowledgements

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Cranfield UNIVERSITY

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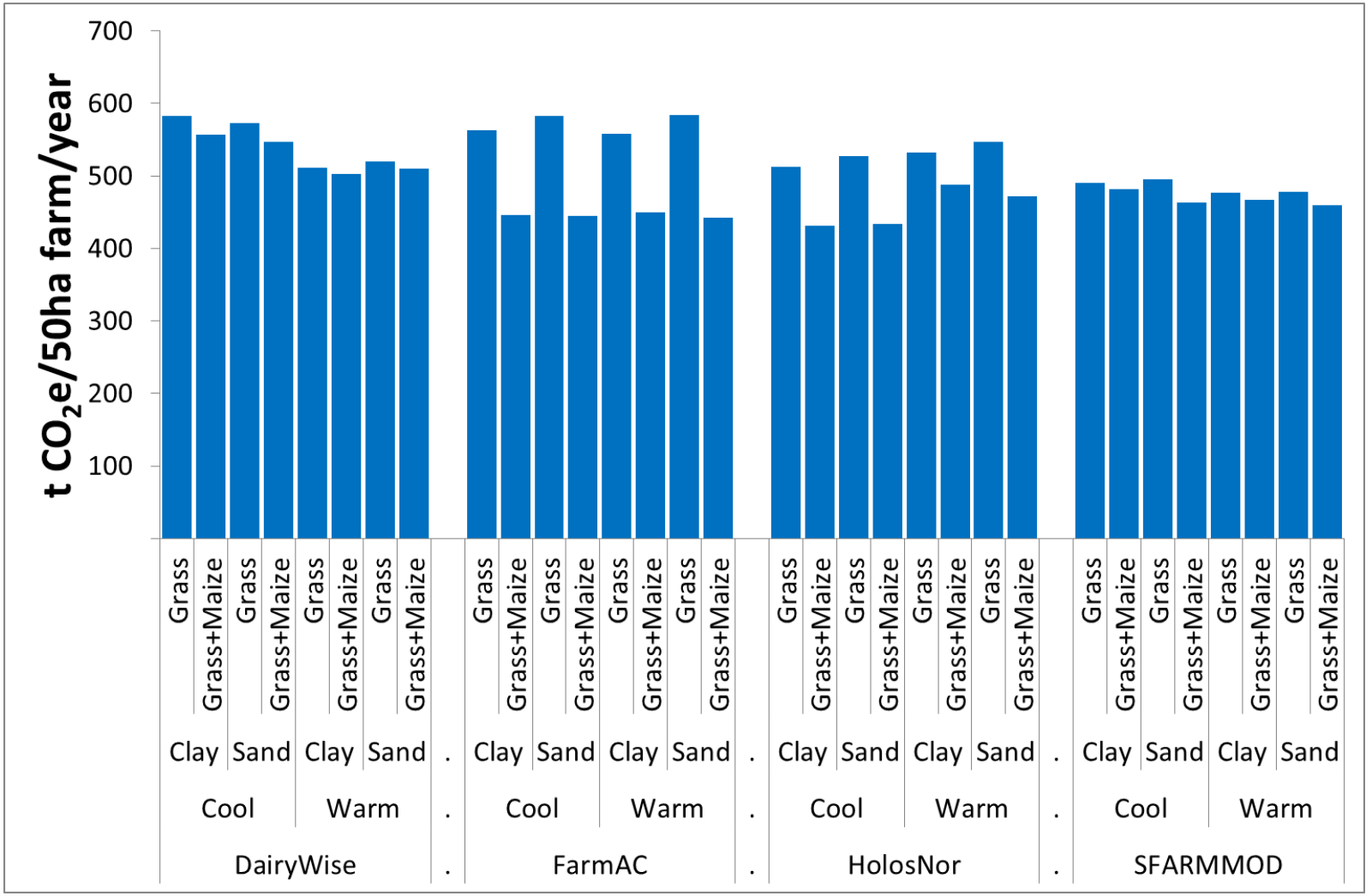
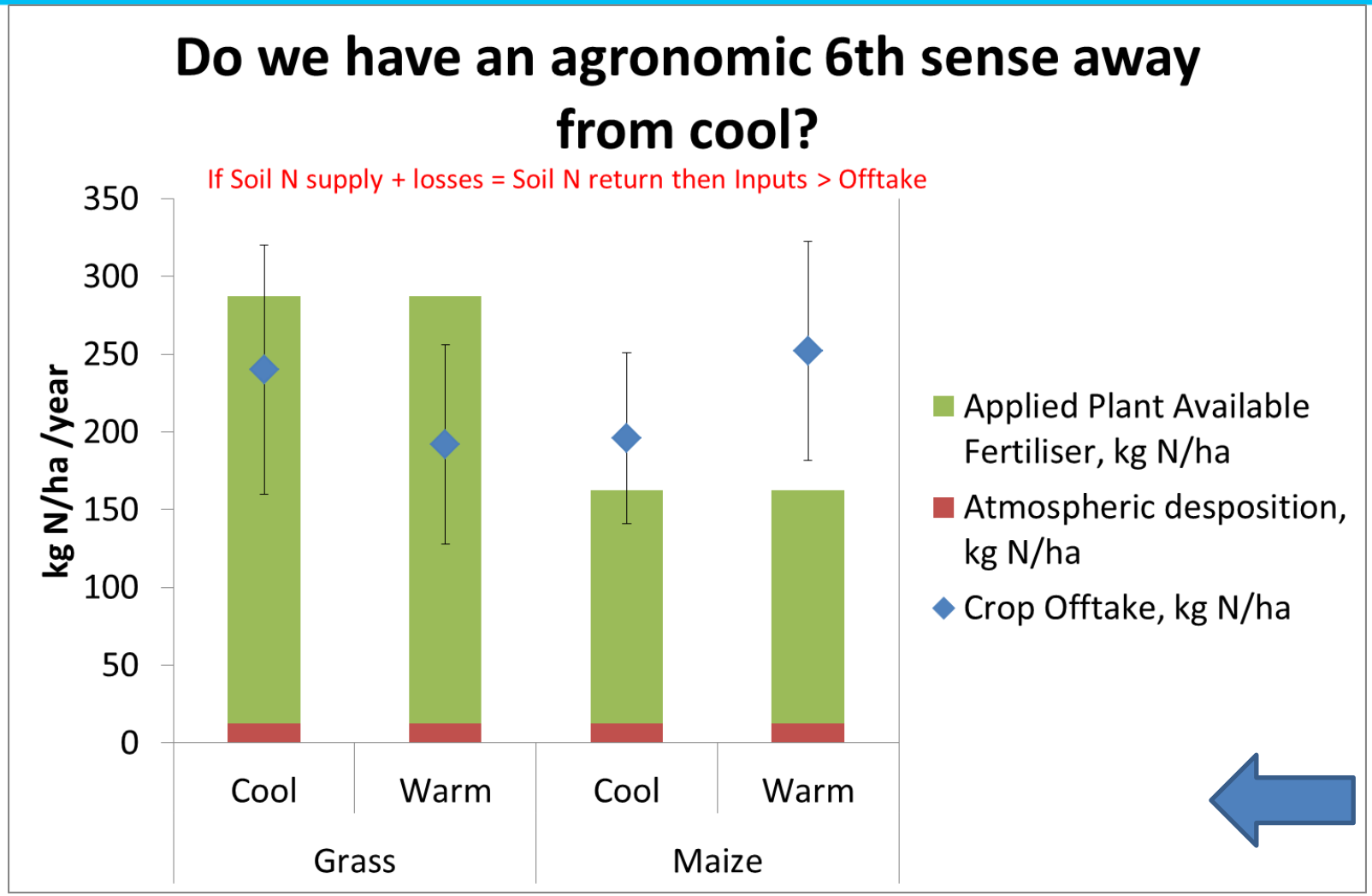
defra
Department for Environment Food and Rural Affairs

Aside 1: Area based comparison



Aside 2: Strange data and intuition



Aside 3: A recommendation

- Using all four models together **“Ensemble modelling”**
  - Robust average and spread of results
  - Triangulation effect
  - The best (and worst) of all models
  - Need to control management factors between models
  - Need to understand the differences and improve the models