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A comparison of farm-scale models to estimate greenhouse gas emissions from dairy farms in Europe

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Background

- Farm scale is essential when upscaling ruminant livestock production
  - significant flexibility in management
  - substantial internal nutrient cycling
- Farm models differ in:
  - Focus (production/economics/environment)
  - Purpose (supporting farmers/farm advisors, regulators)
- How would these differences affect results if the models were used to simulate the same dairy cattle farms?

Models

- SFarMod
  - optimised management
  - emission factors
  - portable
  - 30+ years experience
- Dairywise
  - optimised feed supply
  - empirical emission factors
  - location-specific (Netherlands)
  - 10+ years of experience

Models

- FarmAC
  - user inputs management
  - emission factors (except dynamic soil model)
  - portable
  - 1 year of experience
- HolosNor
  - user inputs management
  - emission factors
  - Canadian model, adapted for Norway
  - 2-3 years of experience

Standard factorial scenarios

Warm x cool climate

Sandy x clay soil

Grass only x grass & maize

Dairy cows + followers (1:1)

600 kg LW & 7000 kg ECM/cow/yr

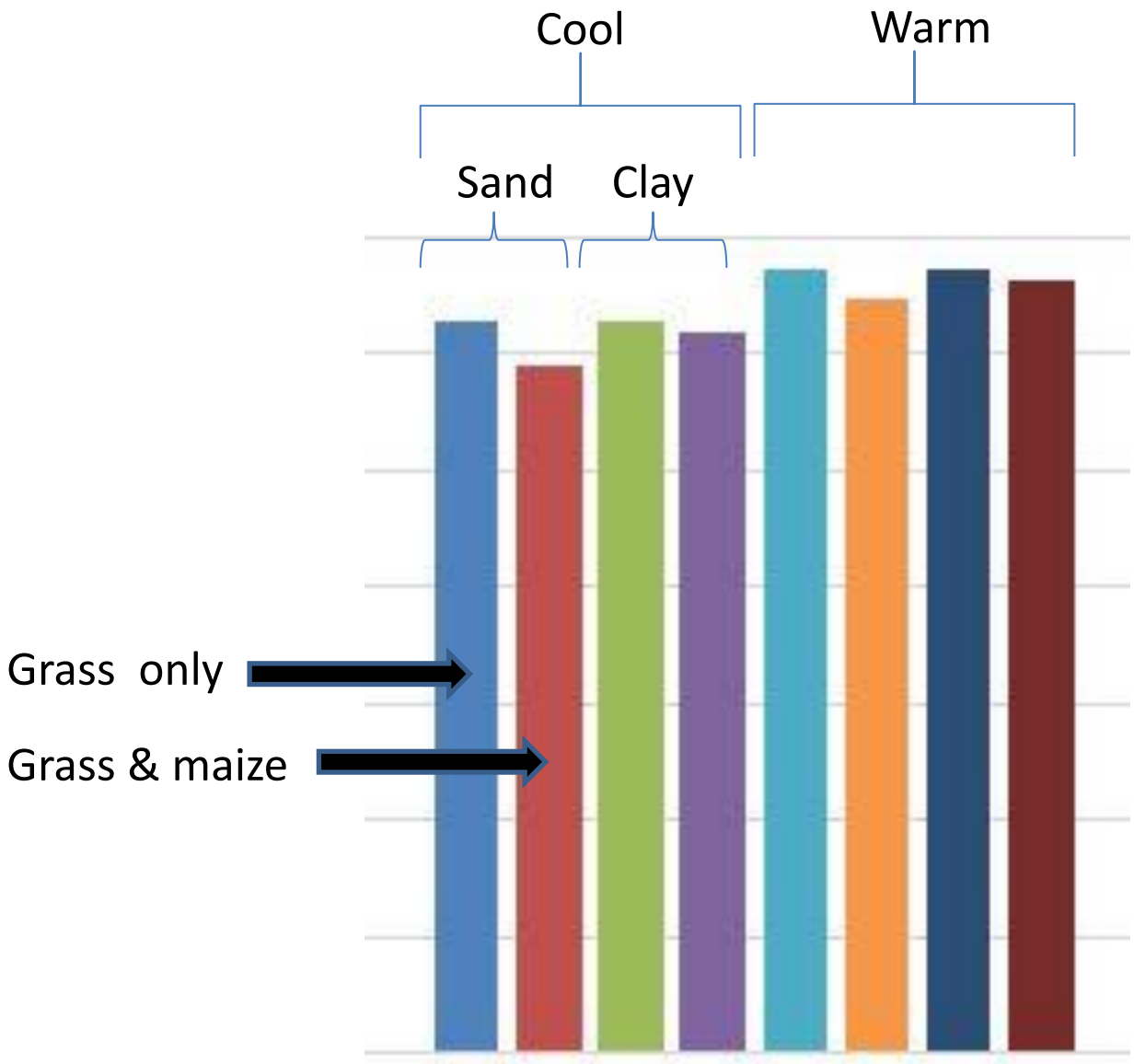
Cool climate grazing 5 months
Warm climate grazing 10 months
16 hours/day grazing

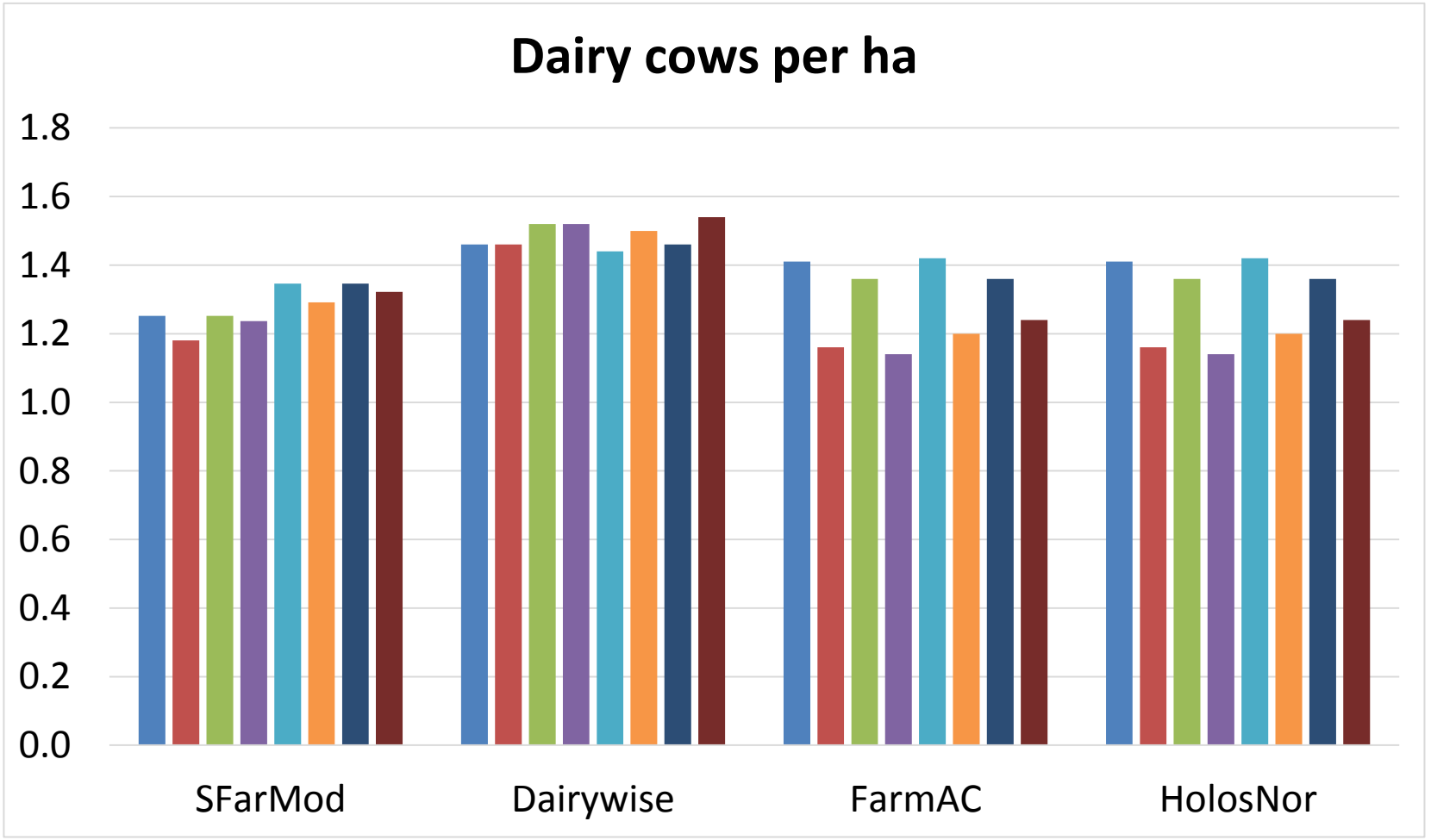
Minimum use of concentrates
No manure import/export

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

RESULTS

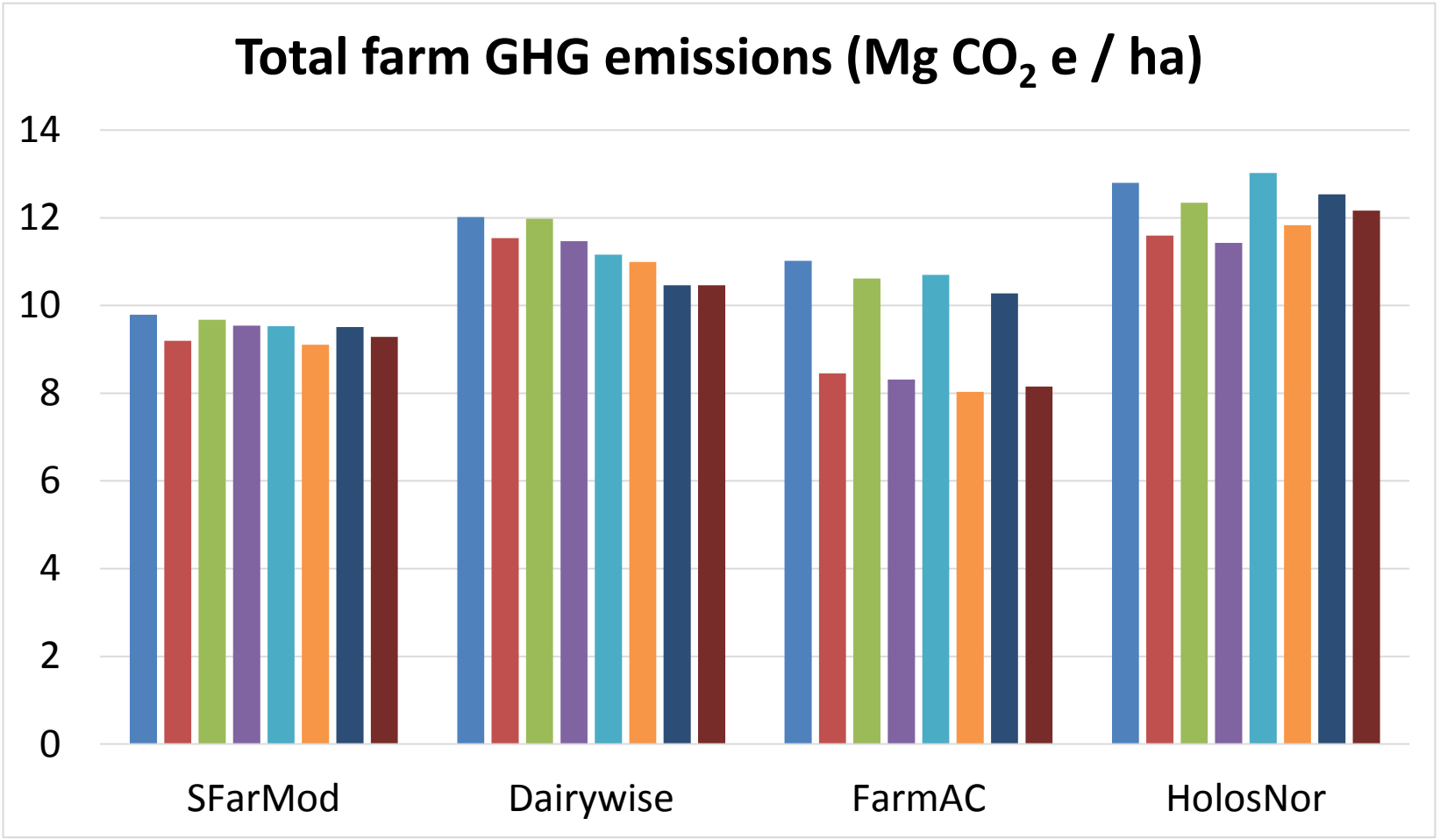

Cool
Warm
Sand
Clay
Grass only
Grass & maize



HolosNor uses FarmAC livestock numbers

Differences in feed requirement models

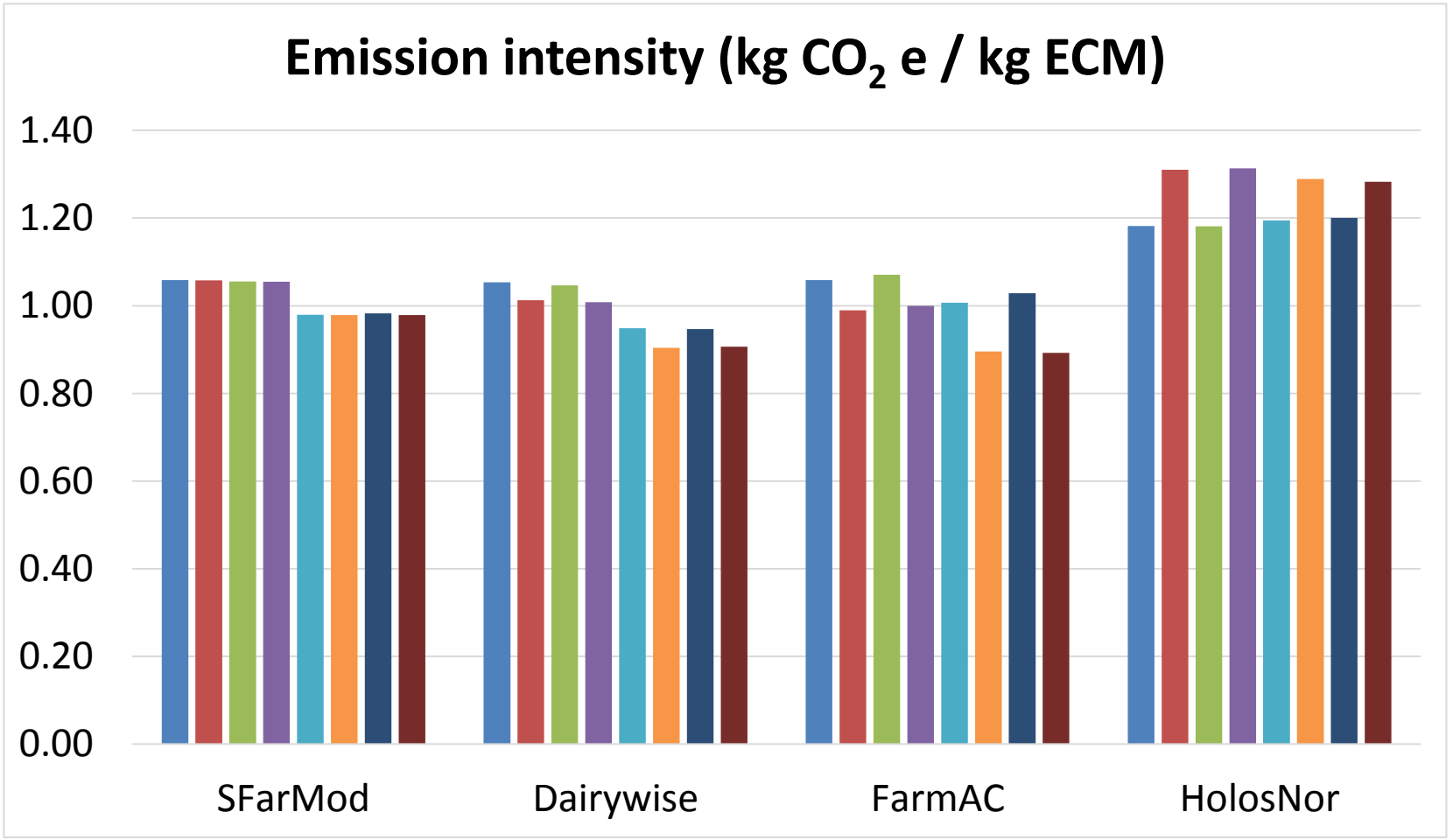
For grass & maize - differences in area allocated to maize



Note – pre-chain/post-chain not simulated

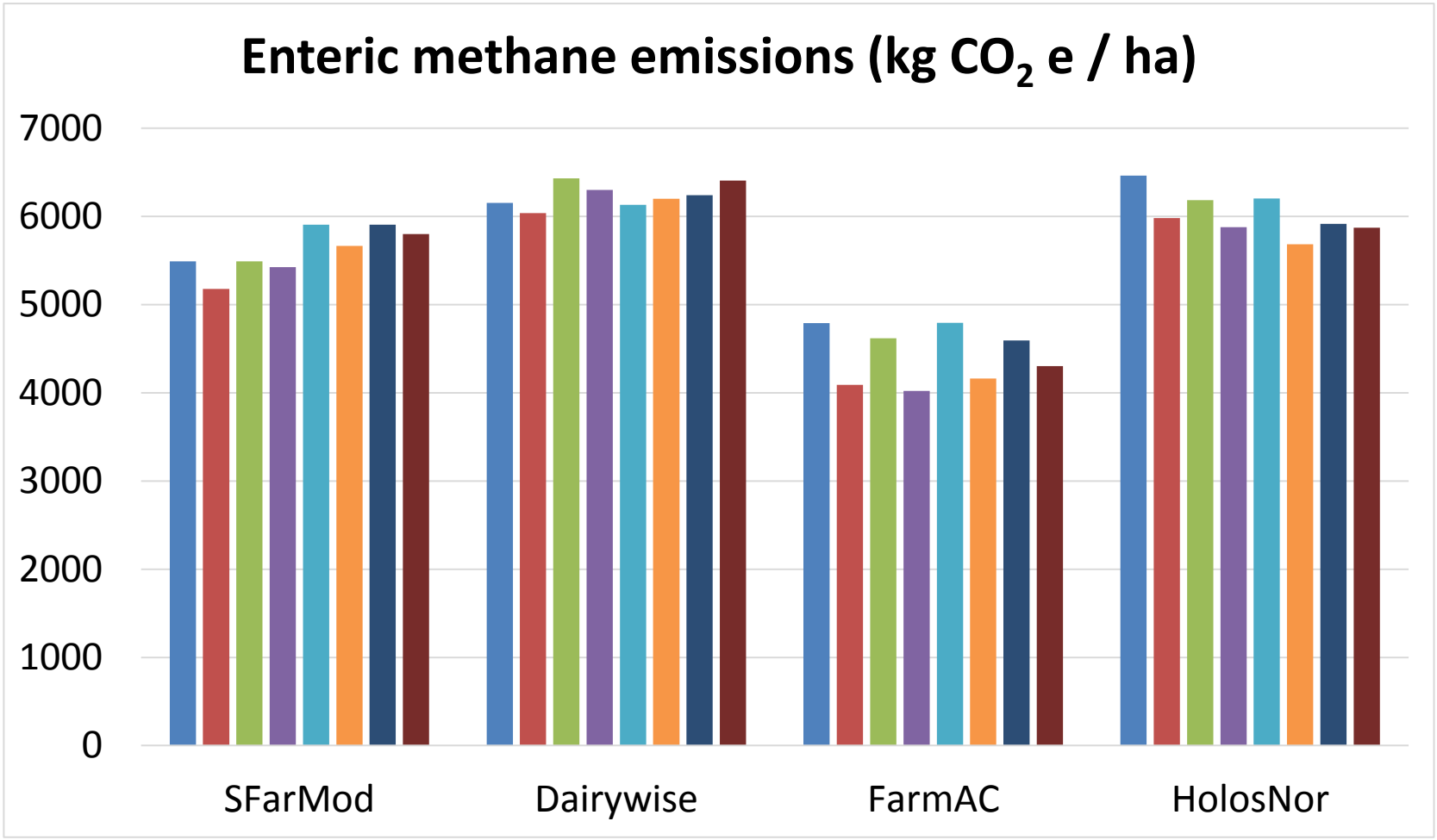
Grass only > grass & maize

Little effect of soil type – true for most variables

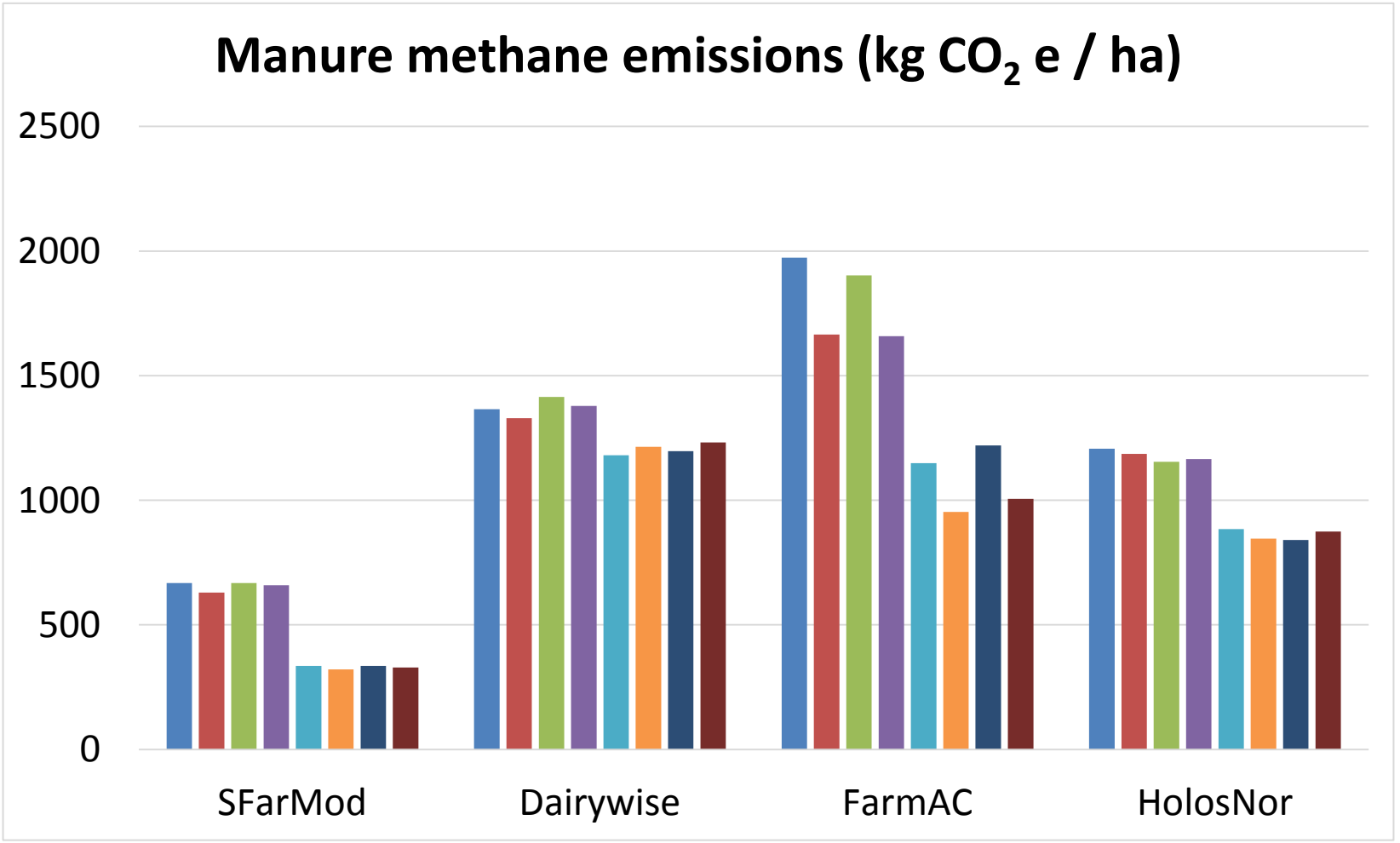


Cool climate > warm

Grass only > grass & maize (except HolosNor)

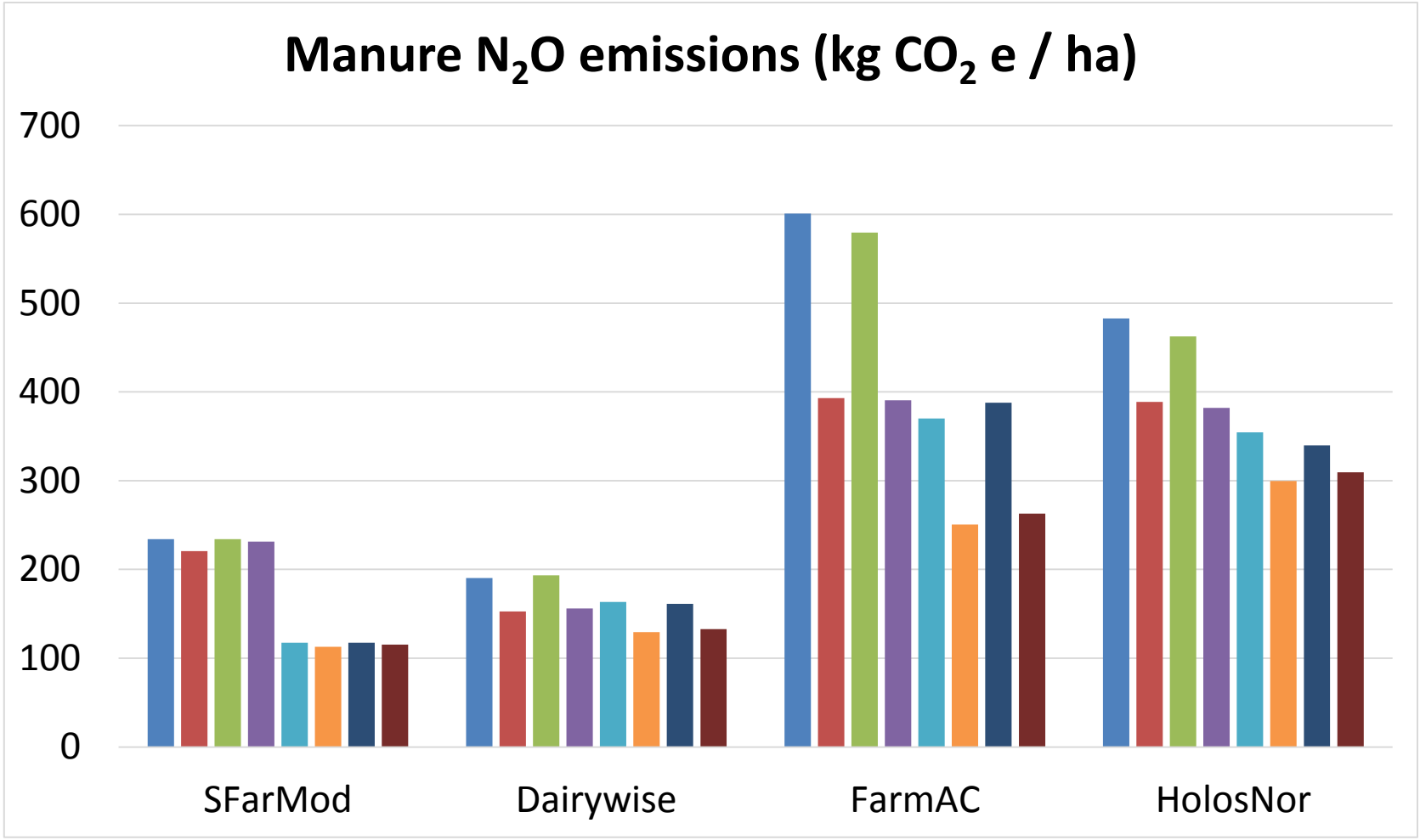


FarmAC low – feed requirement model predicts lower intake necessary to achieve 7000 litres milk/yr



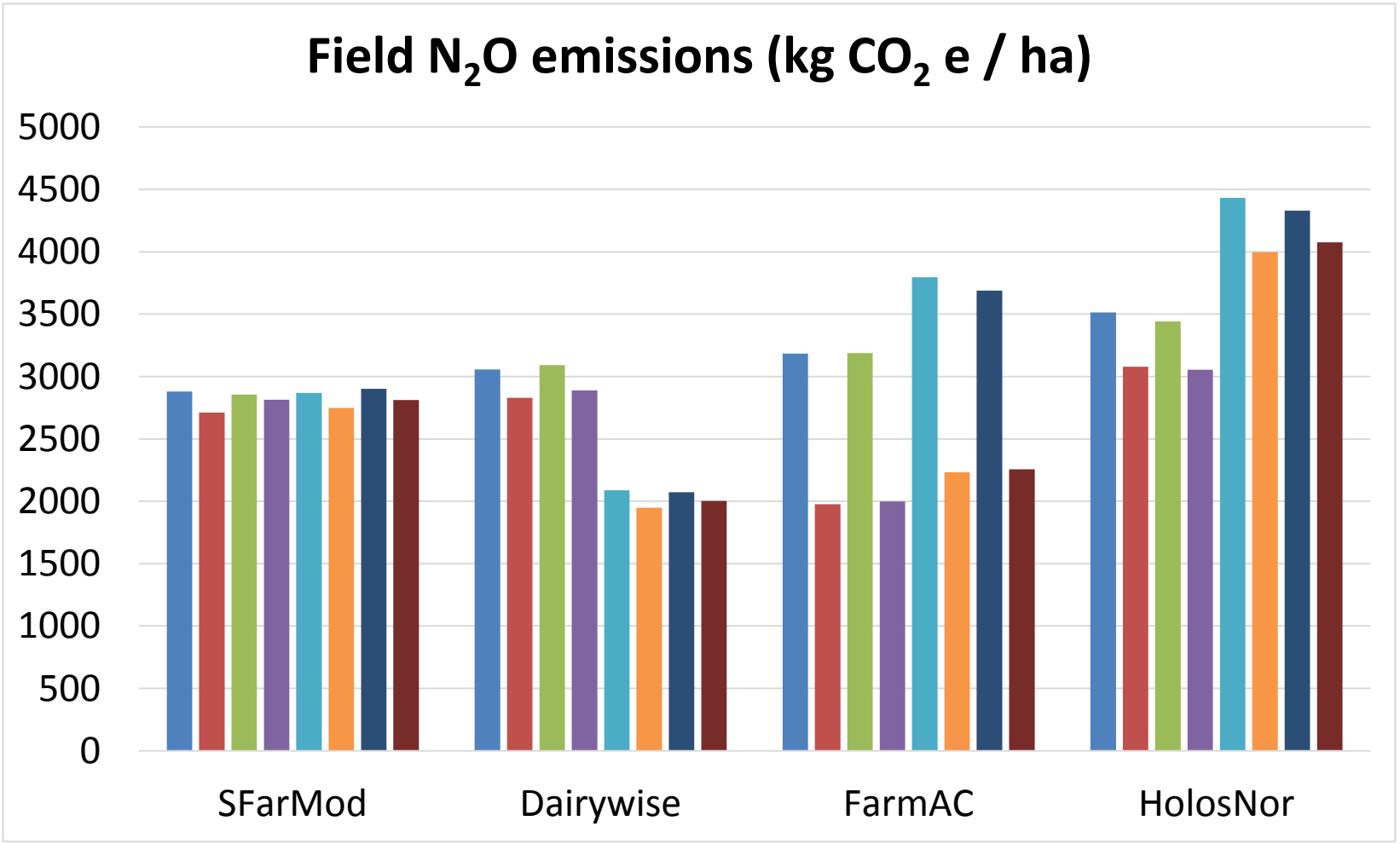
Higher for cool climate (more manure produced in housing)

Dairywise imposes Netherlands manure regulations concerning manure storage

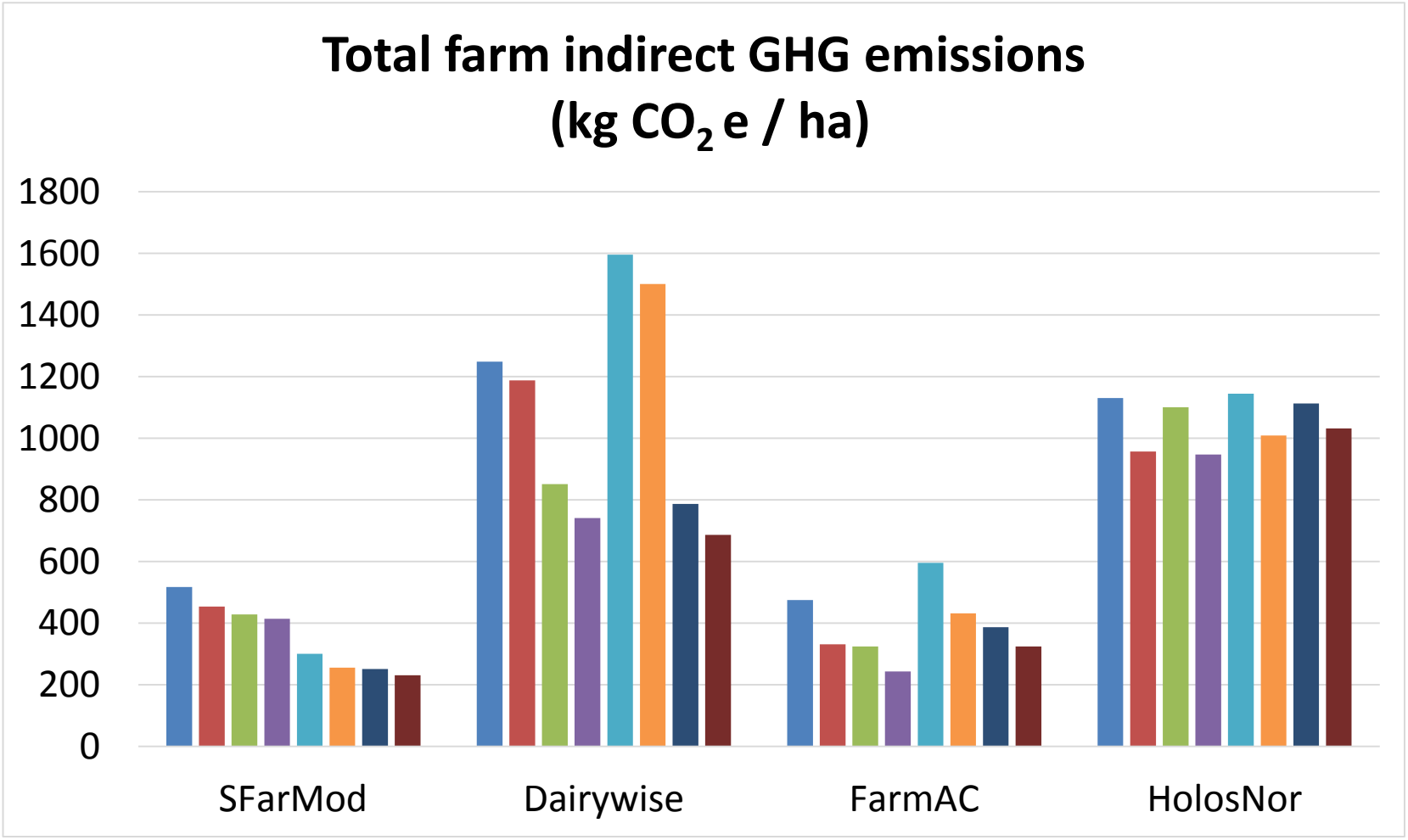


Higher for cool climate (more manure produced in housing)

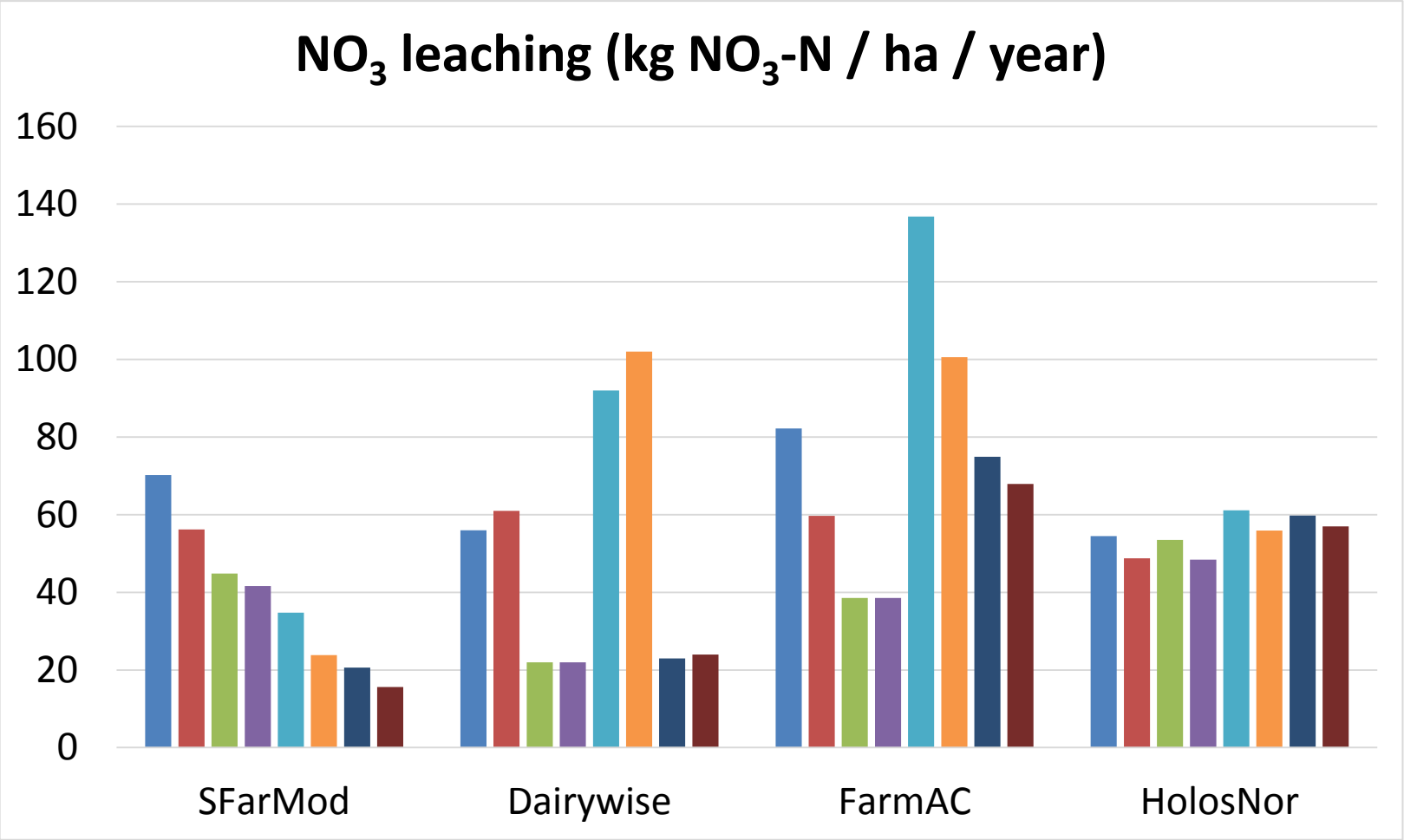
but relationship between models differs relative to methane



Differences between models in how they treat manure N and excretal N



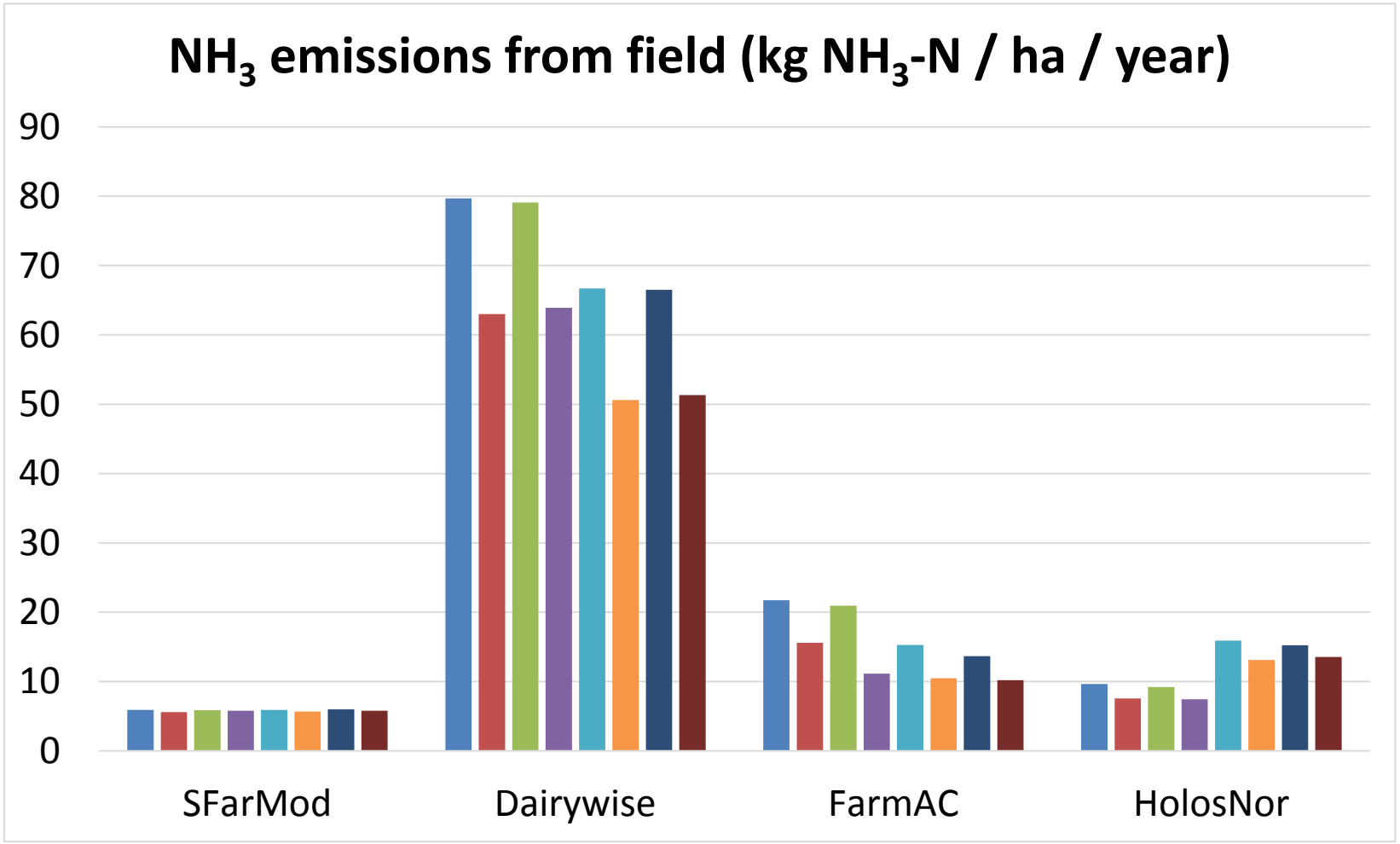
Indirect = nitrous oxide emission resulting from nitrate leaching and ammonia emission



Large differences between models

Grass only > grass & maize

Effect of soil type in some models



Large differences between models (different emission factors)

Grass only > grass & maize

Conclusions (1)

- Total GHG emissions per kg milk and per ha were similar for all models
  - but this disguises some major differences between models
- Little effect of soil type
- All models tended to predict lower emissions for the warm climate
- More work necessary to understand the details of why models differ

Conclusions (2)

- Assumptions concerning farm management are important
  - need for more empirical data and better understanding of processes
- If used to prioritise mitigation measures, these models would give very different answers
- It has been a useful learning exercise