Mitigation of greenhouse gas emissions in dairy farming

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Team Research

Outline

- introduction
- carbon footprint of milk
- selection for less GHG emissions
- research activities CRV
- conclusions

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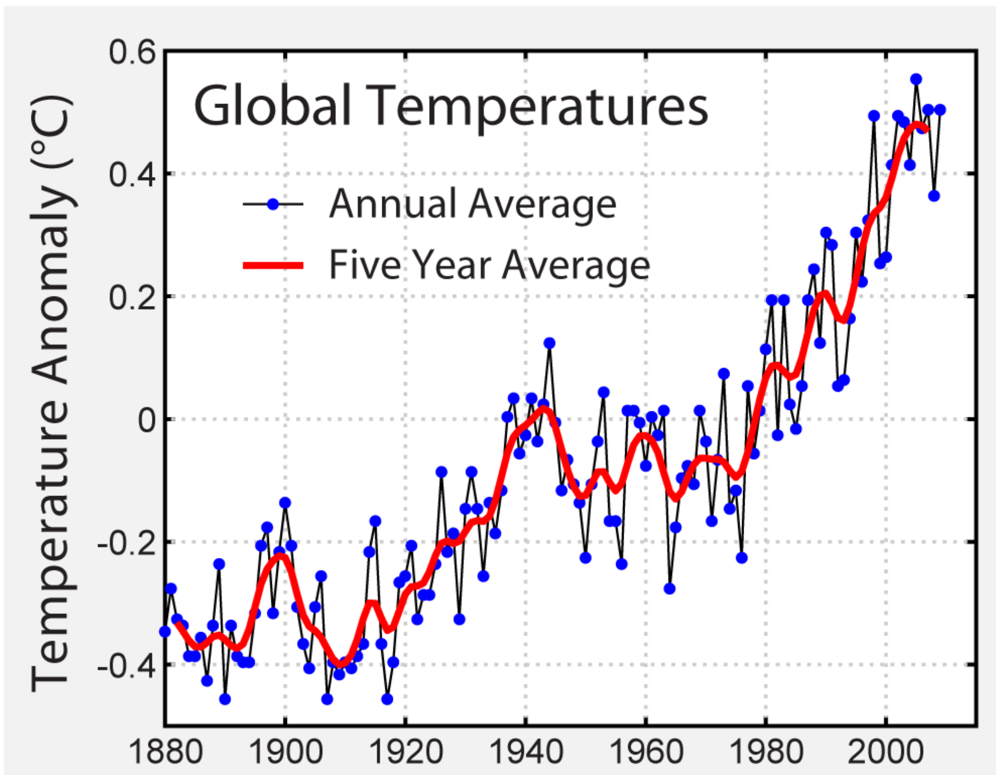
GHG emissions and climate change

- higher levels of GHGs linked to global warming
  - 1900-2000: temperature increase ~0.7 °C
  - 2000-2100: temperature increase 1 - 6 °C ?



Effects of climate change

- more extreme summers and winters
- more variation in rain patterns
- heat stress livestock
- introduction of livestock diseases from other regions (e.g. Blue Tongue)

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Policies to reduce GHG emissions

- aim to limit total temperature increase to no more than 2°C above pre-industrial levels
- mitigation target EU:
  reduction by 20% in 2020 relative to 1990
- legislation
  - EU: Emission Trading Scheme (carbon credits) for energy and industrial sectors
  - NZ: livestock production included in ETS from 2013

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Dairy farming and GHG emissions

- livestock production is an important source
  - ~18% relates to livestock production (FAO, 2006)
  - ~4%   relates to dairy production (FAO, 2010)

- GHG emissions have become a sustainability issue also in dairy farming
  - licence to produce
  - anticipating restrictions on GHG emissions

How to reduce GHG emissions in dairy farming by breeding?

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Emission sources dairy farming

- on farm
  - feed production (N_2O)
  - nitrogen losses pastures (N_2O)
  - enteric fermentation (CH_4)
  - manure management (CH_4)
  - use of fossil fuels (CO_2)
- off farm (until farm gate)
  - production and transport of artificial fertilisers (CO_2)
  - production and transport of concentrates (N_2O, CO_2)

➡ CH_4 and N_2O are main gases

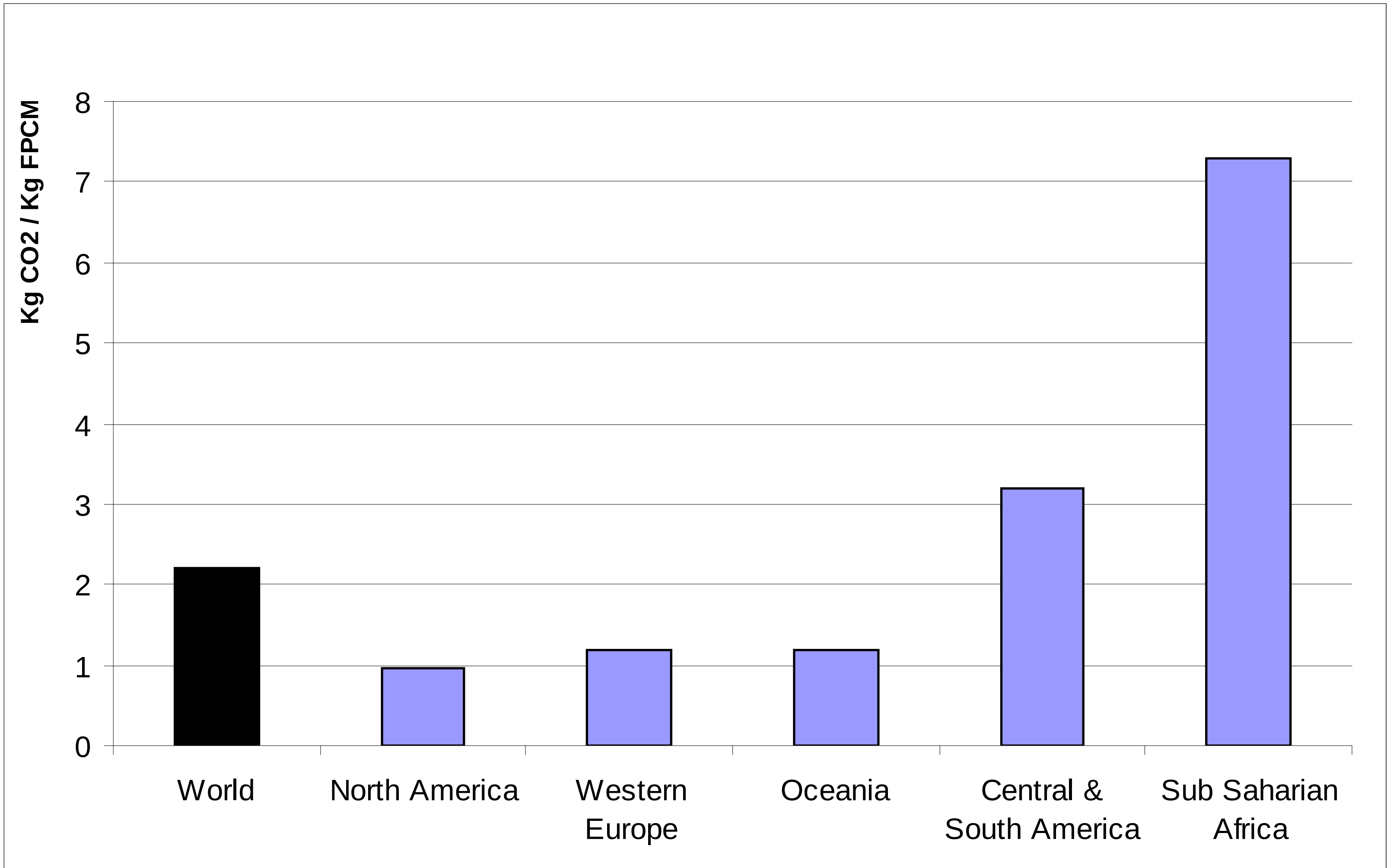
Models to estimate emissions

- whole-farm models can estimate GHG emissions across the dairy production chain
- based on various sub-models
  - e.g. enteric fermentation, nitrogen leaching and crop production
- some uncertainties in current farm models
  - CH_4 production by the cow
  - effect of land use change
    - e.g. how to deal with soybean produciton in South America?

Carbon footprint of milk

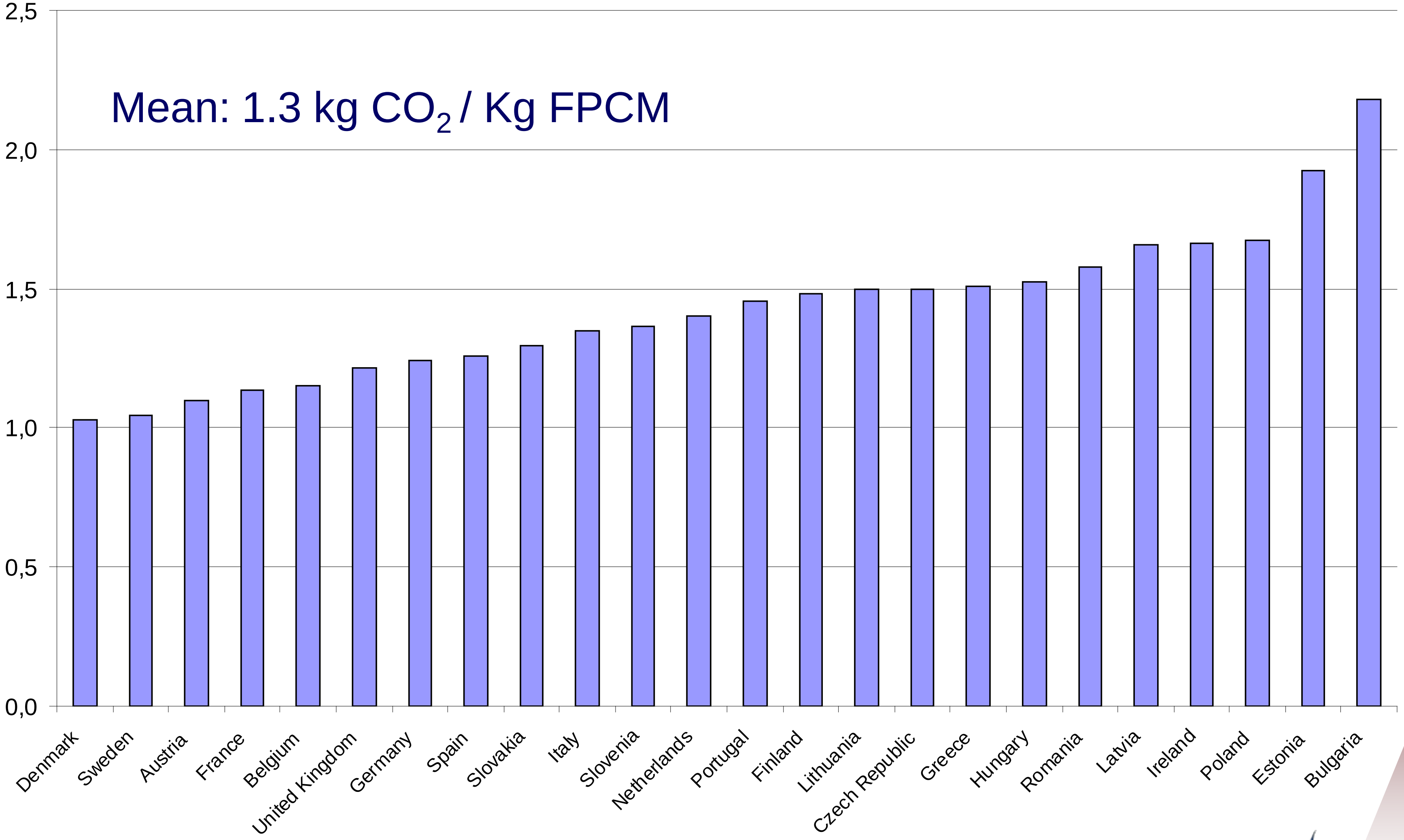
- total of GHG emissions during the different stages of the production cycle of 1 kg of milk
- combines GHGs into CO_2 equivalents according to global warming potential (CH_4: 25 / N_2O: 298)
- global average: ~2 kg CO_2 eq (FAO, 2010)

Carbon footprint of milk per region



(FAO, 2010)

Variation in Europe



(Lesschen *et al*., 2011)

Variation in the Netherlands

(Thomassen et al., 2010)

- analysis of 119 Dutch farms
- average emission: 1.4 kg CO_2 eq
  - 57% on-farm emissions
  - 43% off-farm emissions
- large variation between farms
  - lowest 25%: 1.1 kg
  - highest 25%: 1.7 kg

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Selection for less GHG emissions

- direct selection
  - less CH_4 emissions
- indirect selection
  - higher milk production per lactation
  - improved feed efficiency
  - longer productive lifetime

Selection for less CH_4 emissions

- measuring CH_4 is a major problem
  - climate respiration chambers too expensive
  - tracer gases not very reliable

Selection for less CH_4 emissions

- current studies
  - use of gas analyzer at automated milking systems
  - use of fat composition in milk as a predictor

➡ direct selection for less CH_4 not yet realistic

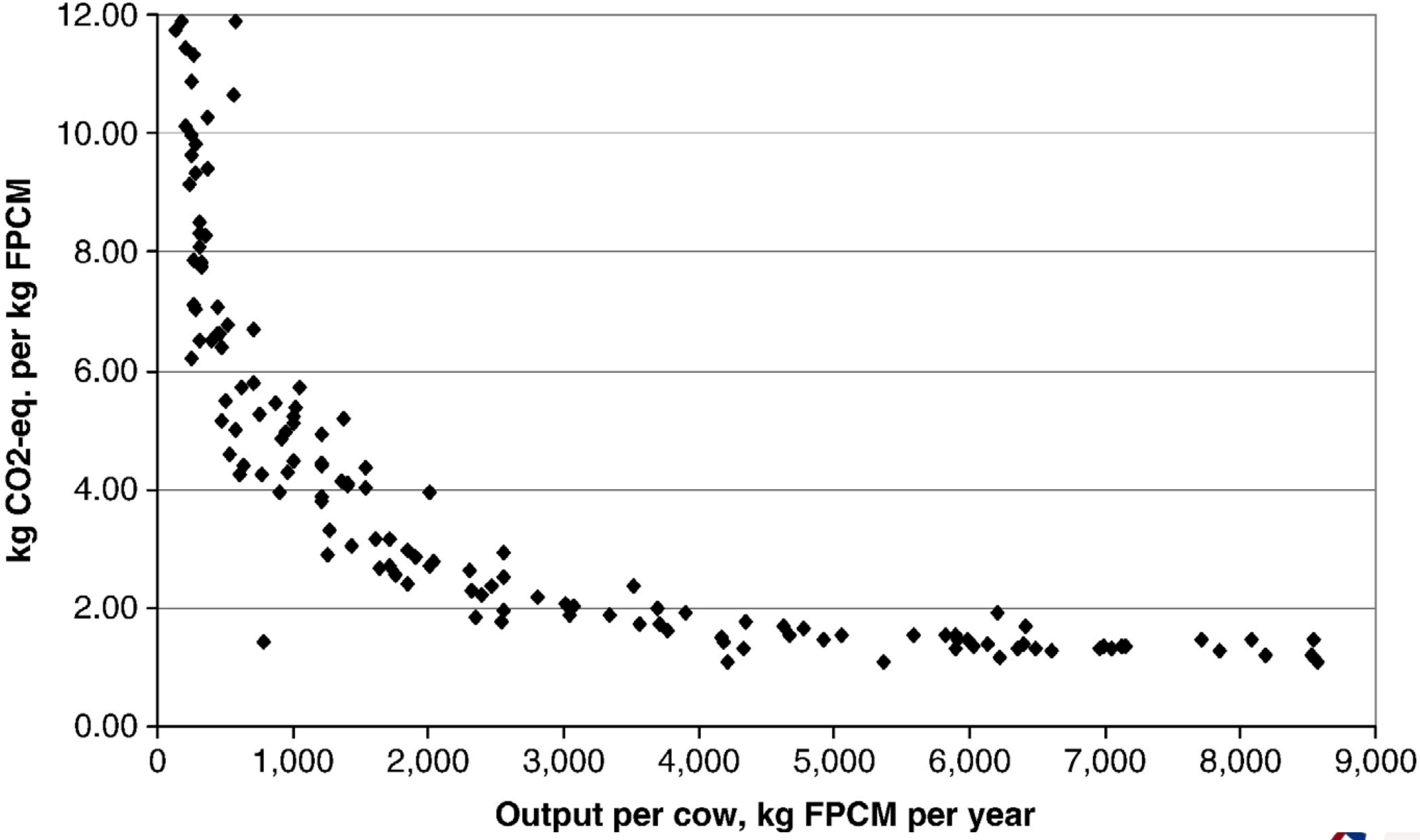
Selection for higher milk production

- higher productions per cow
  - reduce CH_4 emissions from enteric fermentation per kg milk
  - may result in relatively higher inputs of concentrates and N fertilisers

➡ selection for higher milk production has favourable effect especially at low levels

Effect of yearly production

(Gerber *et al.*, 2011)



Selection for feed efficiency

- residual feed intake (RFI): difference between actual and expected feed intake

- lower RFI reduces
  - CH_4 production in rumen (~6% of energy intake)
  - emissions for feed production

- large genetic variation RFI
  - heritability: ~0.3
  - genetic s.d.: >1 kg/day

Selection for feed efficiency

- individual RFI data not widely available

- can we use existing and new datasets to build a reference population for genomic selection?

➡ selection for RFI can have large impact on footprint but is still difficult

Selection for longer productive lifetime

- longer productive life results in fewer youngstock
- selection options
  - direct selection for longevity
  - indirect selection for animal health and fertility (less involuntary culling)
- increasing lifetime from 3.0 to 3.6 lactations results in a 4% lower footprint (Woods *et al.*, 2010)

Breeding programmes and GHG emissions

- GHG emissions not explicitely included in any breeding objective sofar
- improved production efficiency has also reduced carbon footprint of milk
- current breeding objectives (production + longevity) will further improve carbon footprint

→ not yet known how much emphasis on GHG emissions is needed

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CRV and GHG emissions

- global provider of bovine genetics and farm management information
- large variation in market segments
  - high input (Western Europe)
  - grazing (Oceania)
- ambition to contribute to environmental sustainability of dairy farming
  - how to consider GHG emissions in our breeding plan?
  - can we provide management tools?

Research project

- project with Agrifirm and Wageningen University
- aims
  - derive management and breeding options to mitigate GHG emissions
  - develop a GHG information tool at farm level
- activities
  - optimise current whole-farm model
  - evaluate management and breeding options
  - test model at farm level using routinely recorded data

Evaluate breeding options

- simulate effect of changes of individual traits on carbon footprint
  - e.g. milk production, feed efficiency and longevity

- simulate different types of cows
  - high producer cow
  - grazing cow
  - dual-purpose cow

Information at farm level

- feasibility of monitoring GHG emissions using routinely recorded farm data
  - animal data
  - milk production
  - feed production
  - use of concentrates and fertiliser

- farmers can use information at farm level for monitoring and benchmarking

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Conclusions

- GHG emissions are an emerging issue in dairy farming
- whole-farm models can estimate GHG emissions of milk production but still include uncertainties
- carbon footprint of milk varies largely across countries, farms and animals

Conclusions

- improved lifetime efficiency is a key option to mitigate GHG emissions
- historical increases in production efficiency have greatly improved carbon footprint
- dairy improvement organisations can help improving environmental efficiency by providing good genetics and management information

Acknowledgments

- Project partners

agrifirm

WAGENINGEN UNIVERSITY
WAGENINGEN UR

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Thank you for your attention

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