# Dairy production and the carbon cycle

## the importance of carbon sequestration

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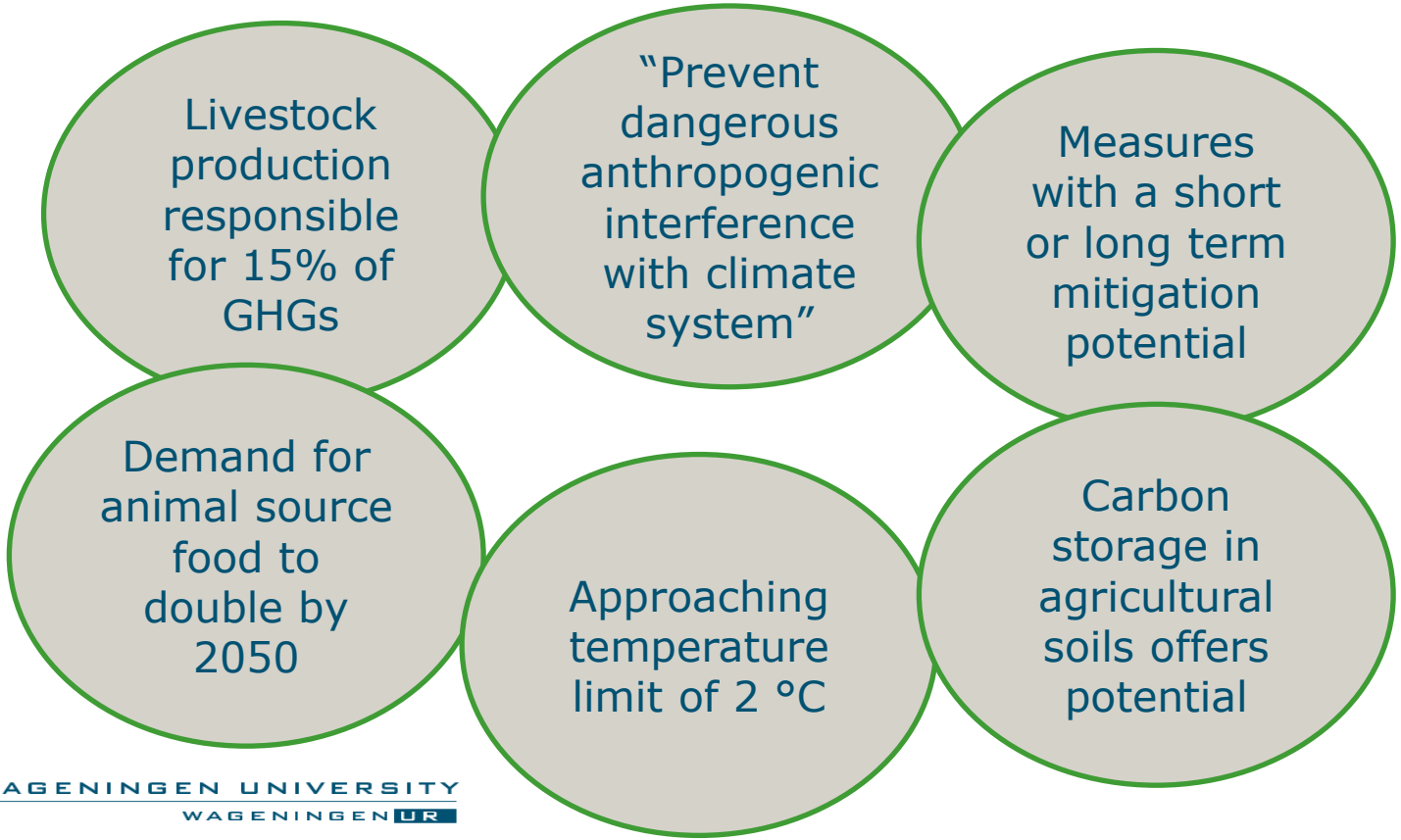
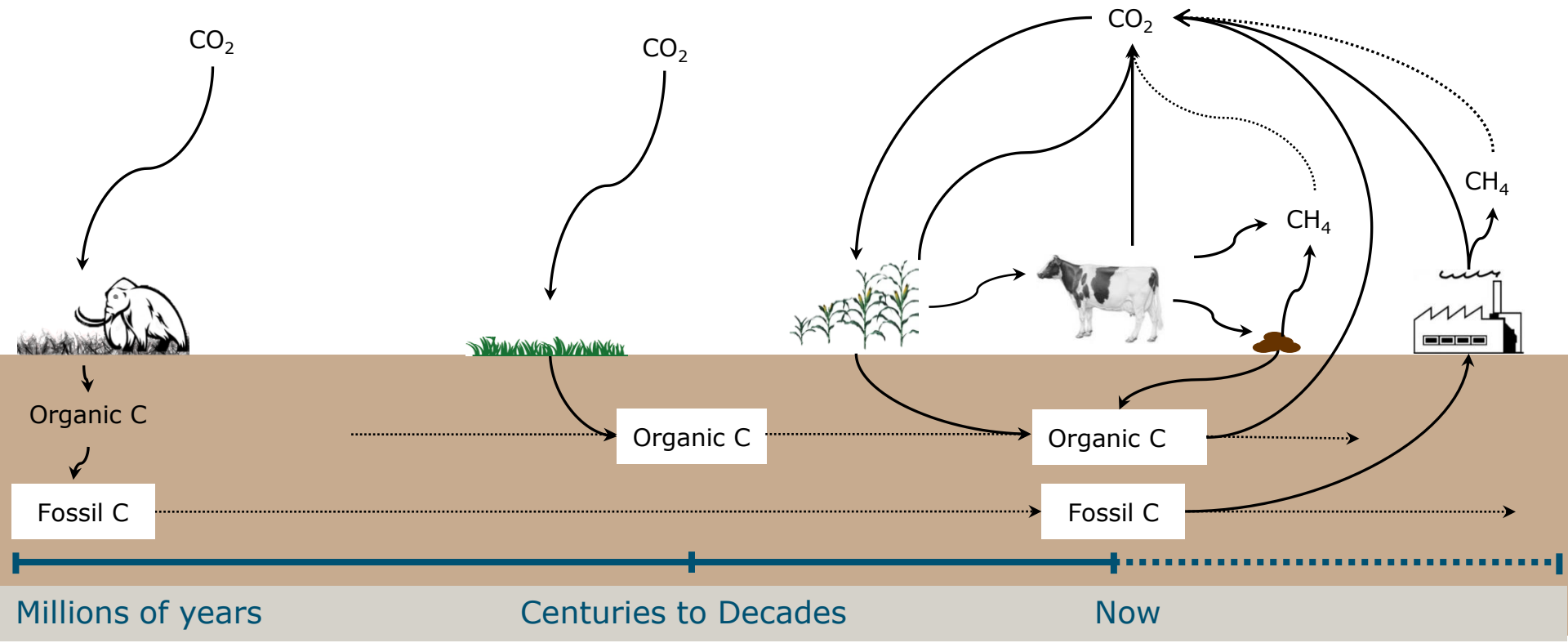
# Reducing global warming?



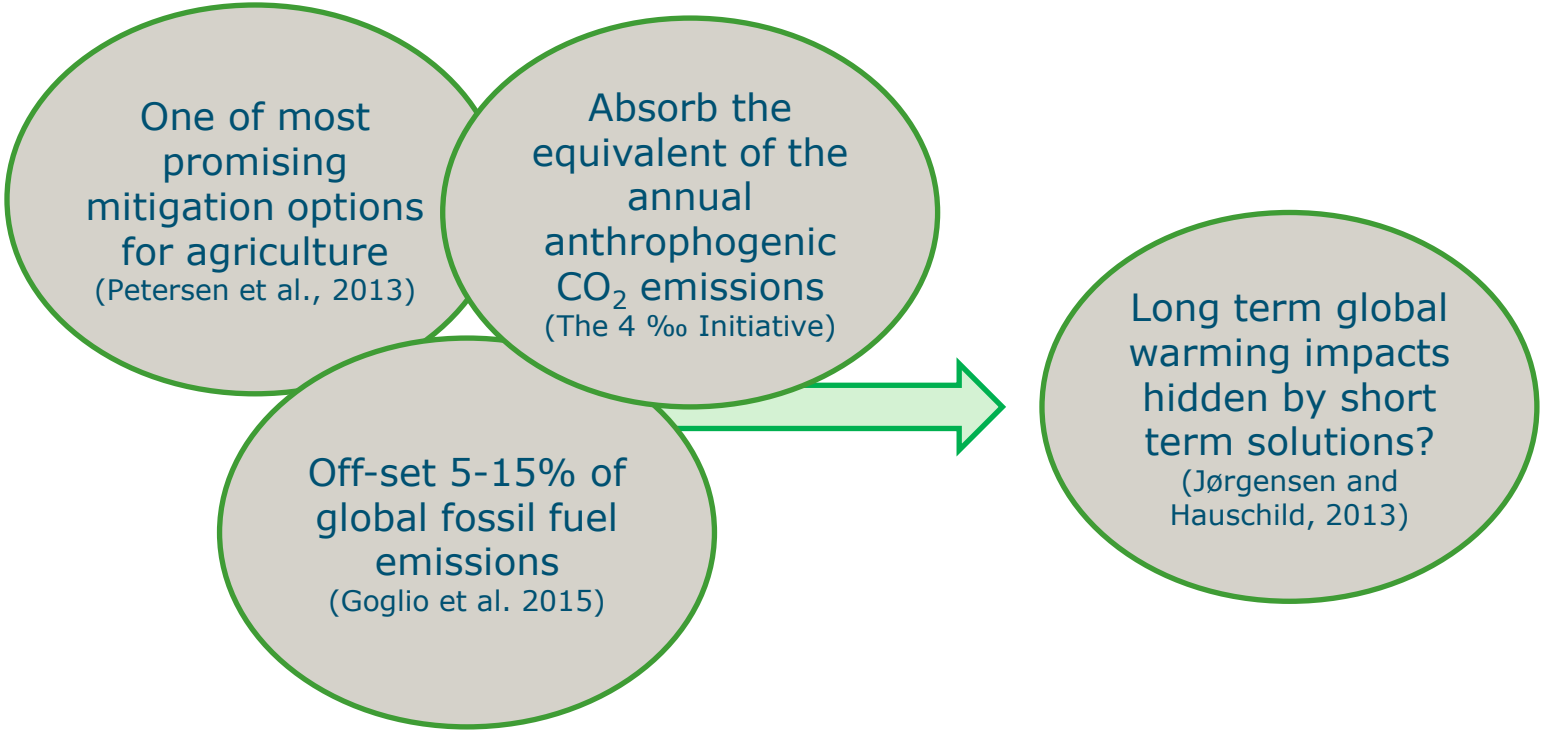
# Content

- Dairy production and the carbon cycle
- Climate impact of greenhouse gases
- Case study: grass based vs maize based system
- Results: the importance of C sequestration
- Conclusions

# Dairy production and the carbon cycle

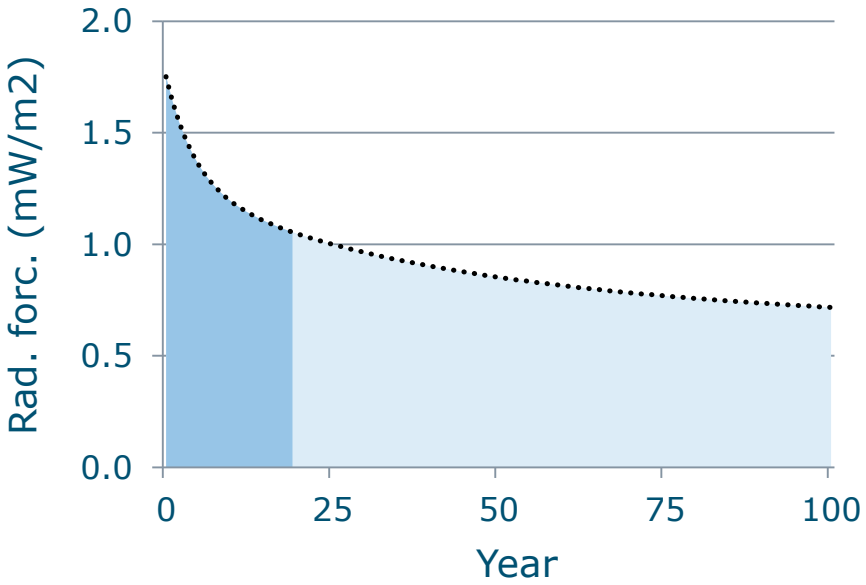


# Importance of soil carbon sequestration?

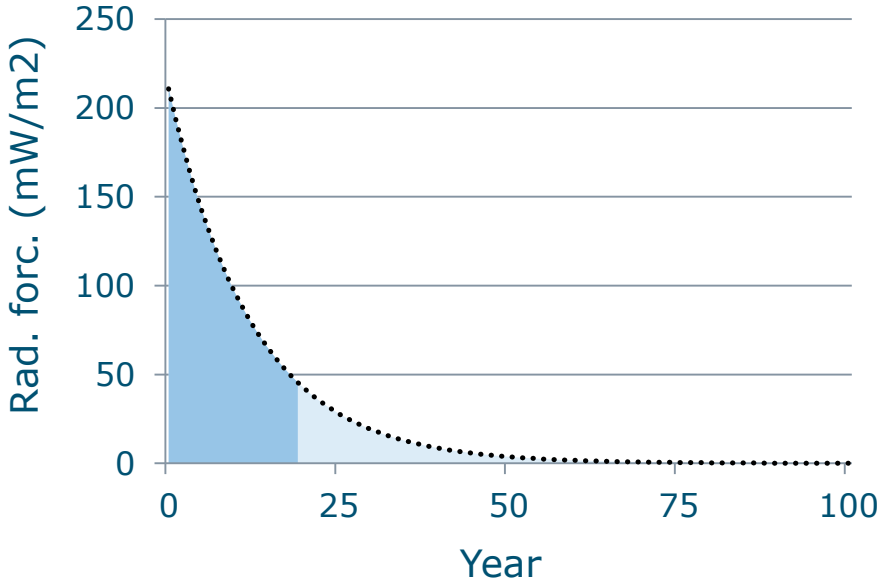


# Climate impact of $CO_2$ and $CH_4$

Radiative forcing of one million tonnes of $CO_2$




Radiative forcing of one million tonnes of $CH_4$




Persson et al. 2015 (based on AR5, IPCC 2013)

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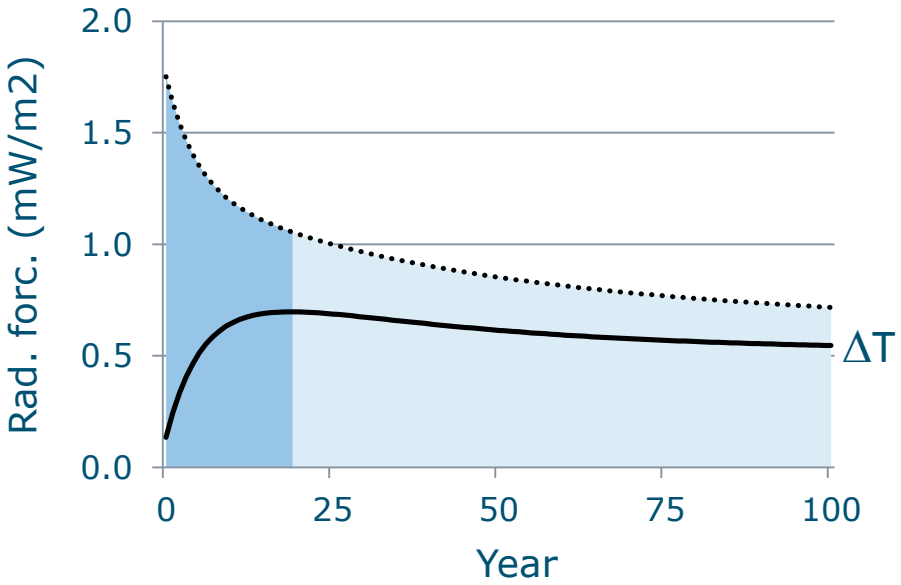


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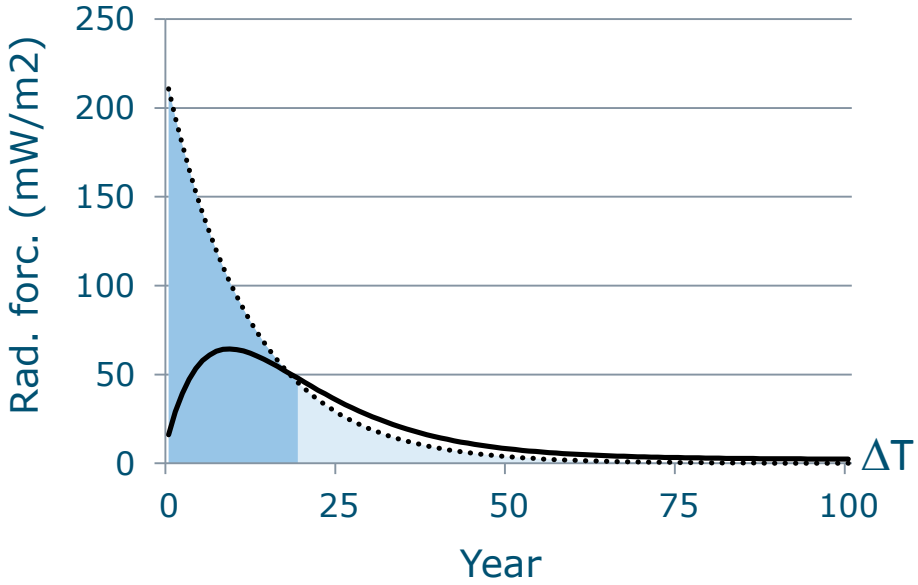
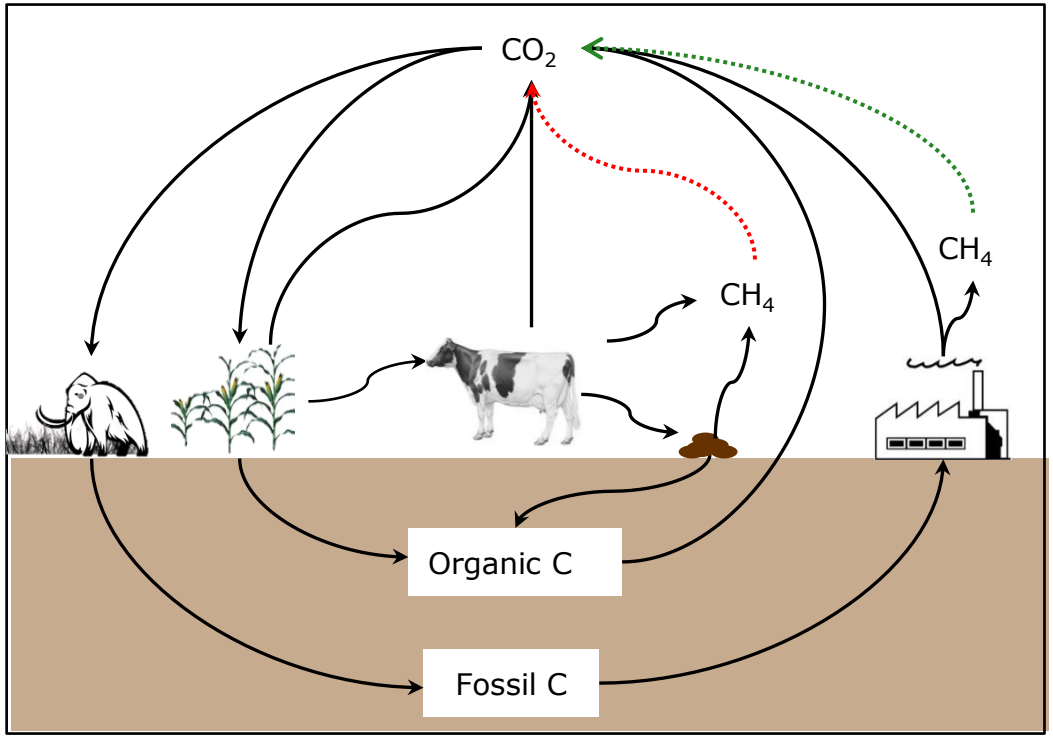



Persson et al. 2015 (based on AR5, IPCC 2013)

# Biogenic versus fossil $CH_4$




- Atmospheric $CH_4$ is broken down to $CO_2$
- Short term C cycle excluded → $CO_2$ from biogenic $CH_4$ excluded (·····)
- Long term C cycle included → $CO_2$ from fossil $CH_4$ included (·····)

# Case study

## Aim

Determine the importance of carbon sequestration regarding the GWP of dairy production at various time scales

# Method

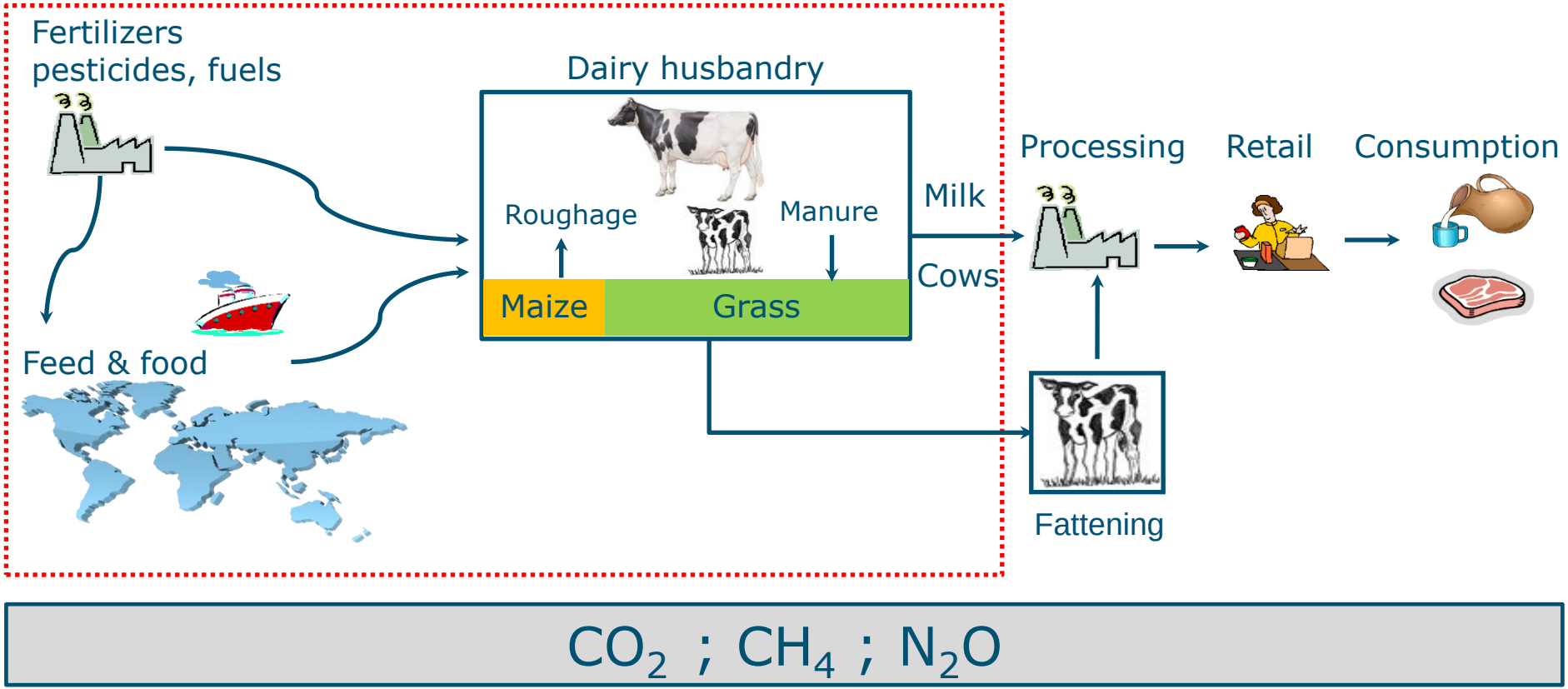
grass based [Farm A] vs maize based [Farm B]

| | | Farm A [13] | Farm B [27] |
|---|---|---|---|
| Land area | [ha] | 35 | 70 |
| Grassland | [%] | 99 | 54 |
| Maize land | [%] | 1 | 32 |
| Dairy cows | [#] | 57 | 124 |
| FPCM | [kg $cow^{-1}$ $yr^{-1}$] | 8,047 | 9,082 |
| FPCM | [kg $ha^{-1}$ $yr^{-1}$] | 13,449 | 18,361 |

FADN, 2011;2012;2013

- How does C seq. affect the GWP of the farms over time?
- How does C seq. affect the comparison between farms?

# Cradle-to-farm gate analysis



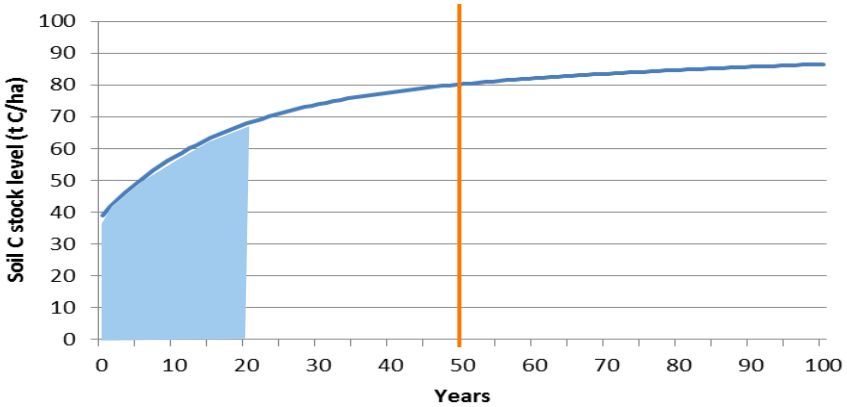

$CO_2$ ; $CH_4$ ; $N_2O$

# Carbon sequestration in grasslands

## Introductory Carbon Balance Model (ICBM)

(Kätterer and Andrén, 1999)

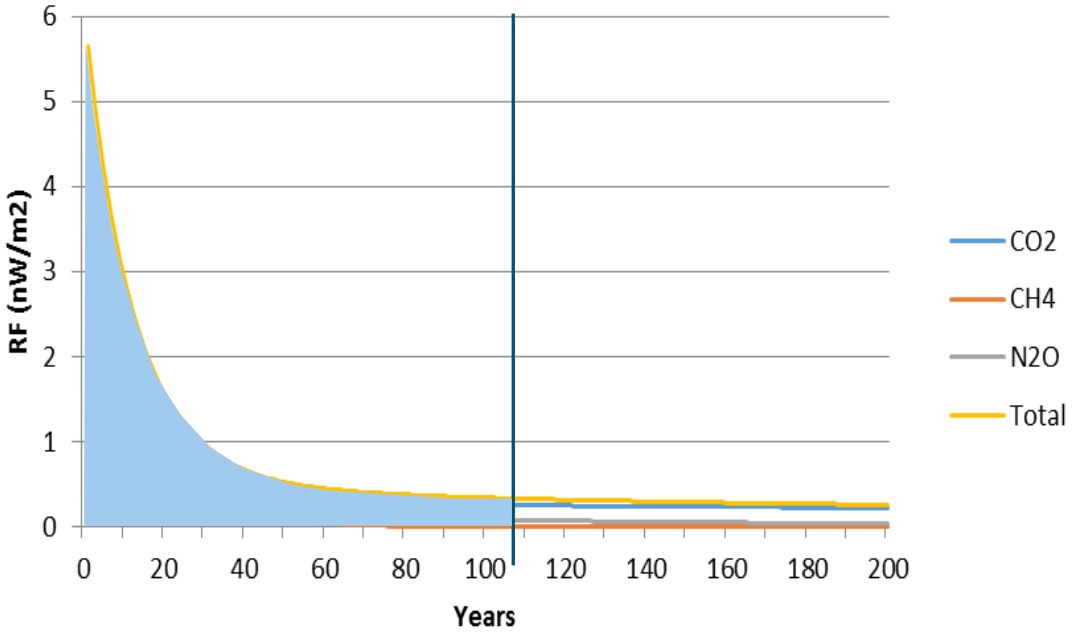
- Simulates soil C dynamics based on soil characteristics, nitrogen input, climatic conditions, and management operations
- Calibrated and tested for the Dutch situation by Vellinga et al. (2004)




- ✓ Most optimal scenario C seq. grassland → what is the maximal potential?
- ✓ No increase in soil C maize land
- ✓ No C losses grass- and maize land

# Results – pulse of emission

(per ton fat-and-protein-corrected milk)



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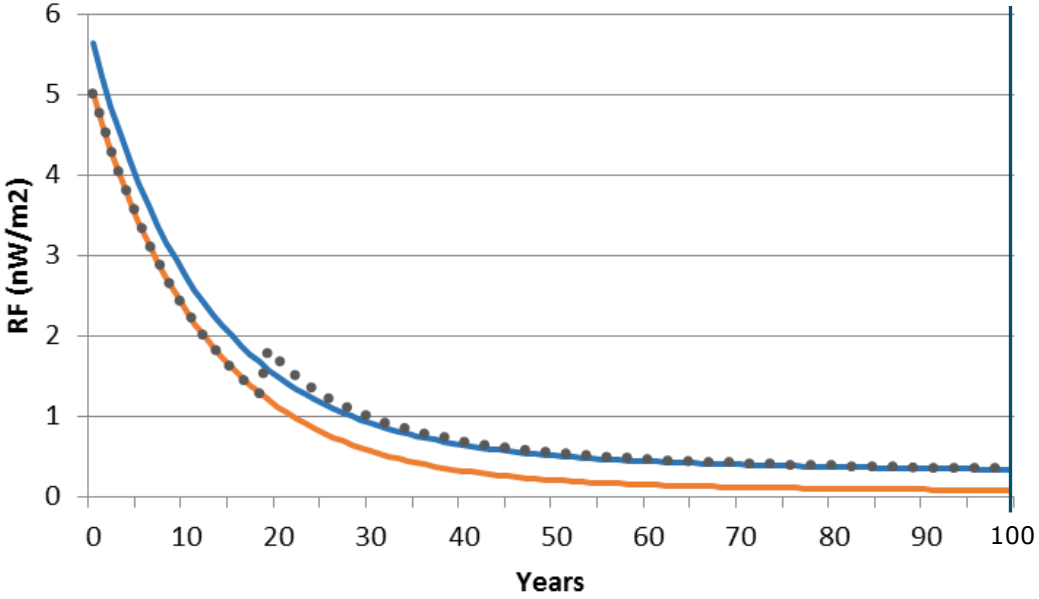
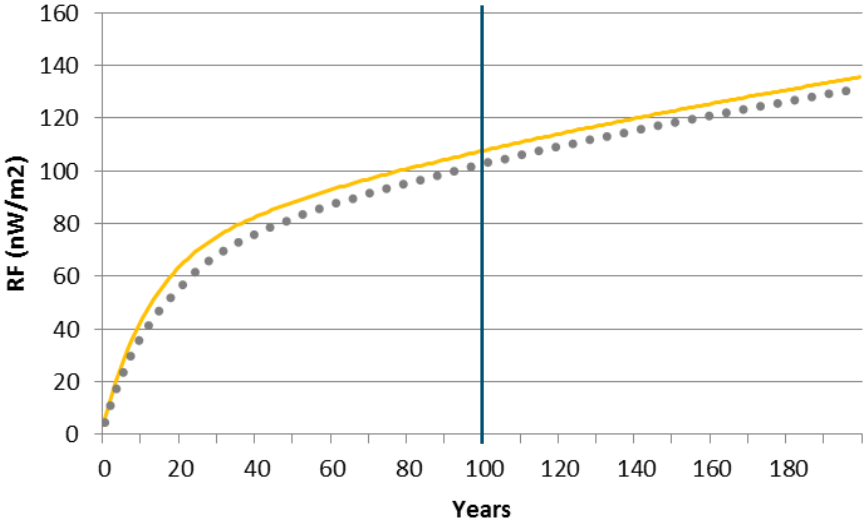



GWP (100 yrs) / t FPCM

| | |
|---|---|
| Farm A (grass) | (kg $CO_2$eq) |
| Excl C seq | 1139 |

# Results – continuous emission

(per ton fat-and-protein-corrected milk $yr^{-1}$)




GWP (100 yrs) / t FPCM

Farm A (grass)

10% lower with C-seq compared to without C seq

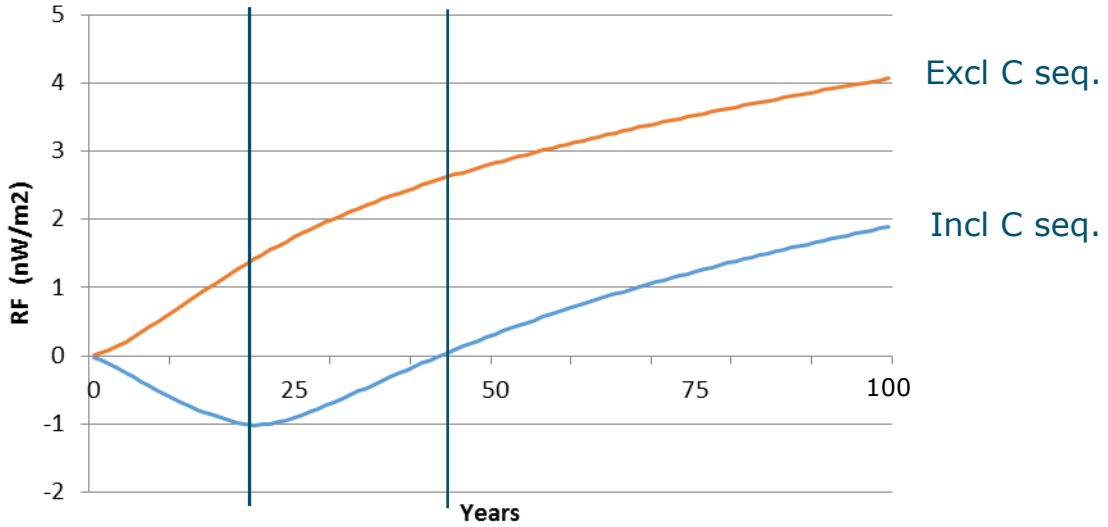
12.2 billion litres of milk (NL, 2013)

1.4 billion tonnes of $CO_2$ per year;

$\Delta T$ 0.004 °C lower with C-seq compared to without C-seq

# Results – continuous emission

(per ton fat-and-protein-corrected milk $yr^{-1}$)




RF per ton FPCM of Farm A (grass) relative to that of Farm B (maize)

# Conclusions

- Mitigation potentail of carbon sequestration highly dependent on **grassland age** and **storage time**
- Carbon sequestration can lower the impact of a system for a **certain time** period → buying time
- At the long term, measures to **reduce annual emissions** might be more efficient than carbon sequestration for reducing global warming

# Thank you for your attention

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