Organic Farming in a Changing Climate

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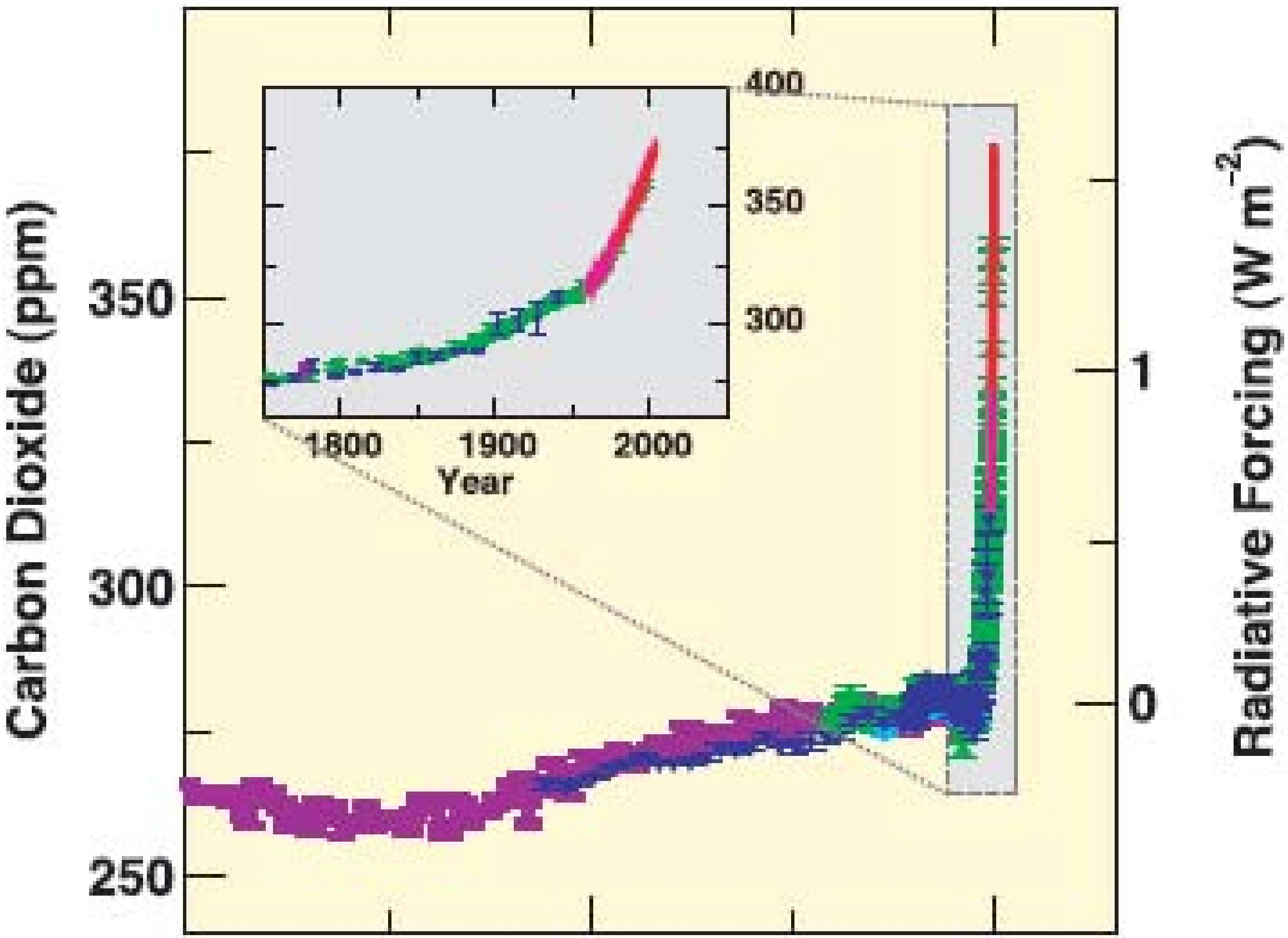
Content

- Climate change (CC)
- GHG emissions from agriculture land use/ crop production
- Mitigation of CC - role of organic farming
- Adaption to CC in organic farming
- Conclusions

Atmospheric concentration of CO_2 (Ice core and modern data)

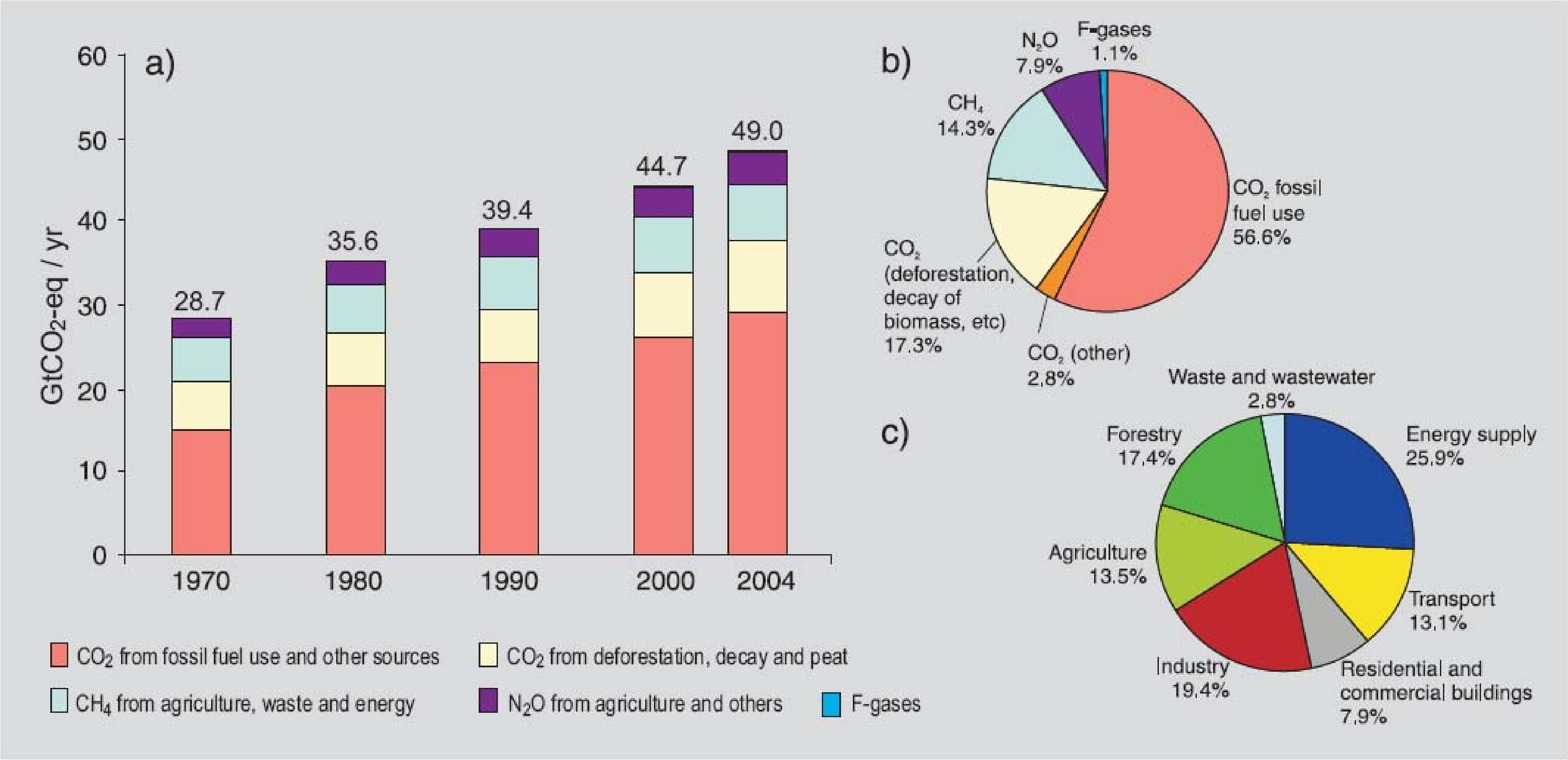


10000 5000 0

Time before 2005

IPCC, 2007

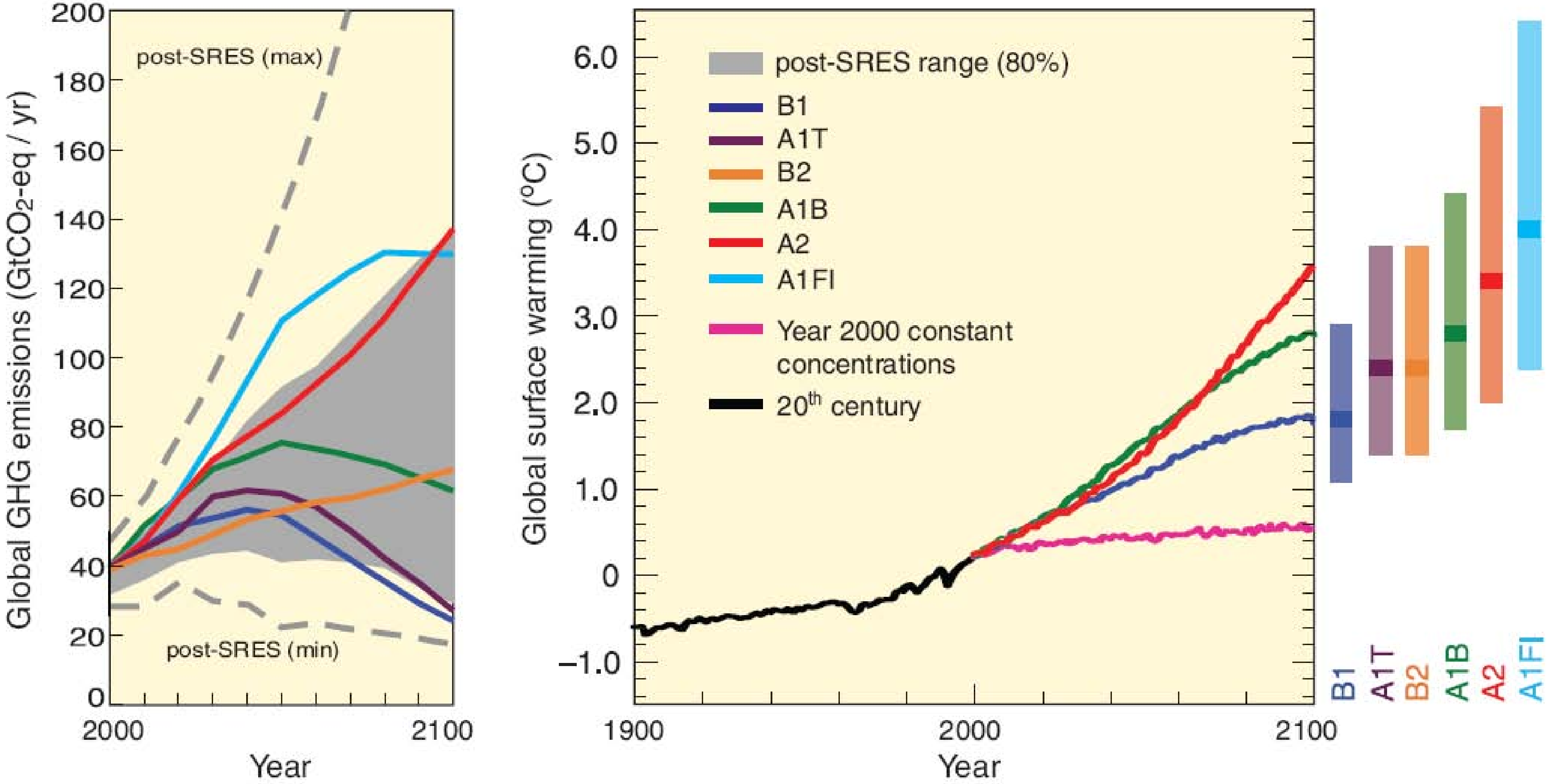
Global anthropogenic GHG emission 1970-2004



CH_4: 25 CO_2 equiv – N_2O: 298 CO_2 equiv

IPCC, 2007

Scenarios for GHG emissions 2000-2100



IPCC, 2007

Expected climate change at higher latitudes (e.g. Sweden)

- Warmer (+2.5°C during summer, and more during winter and fewer cold days and nights
- Warmer and more frequent warm days and nights
- Heatwaves more frequently
- More rain and more heavy rainfall incidents (+10-25% in western Sweden, autumn-winter-spring)

IPCC,2007

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Roles of agriculture in climate change

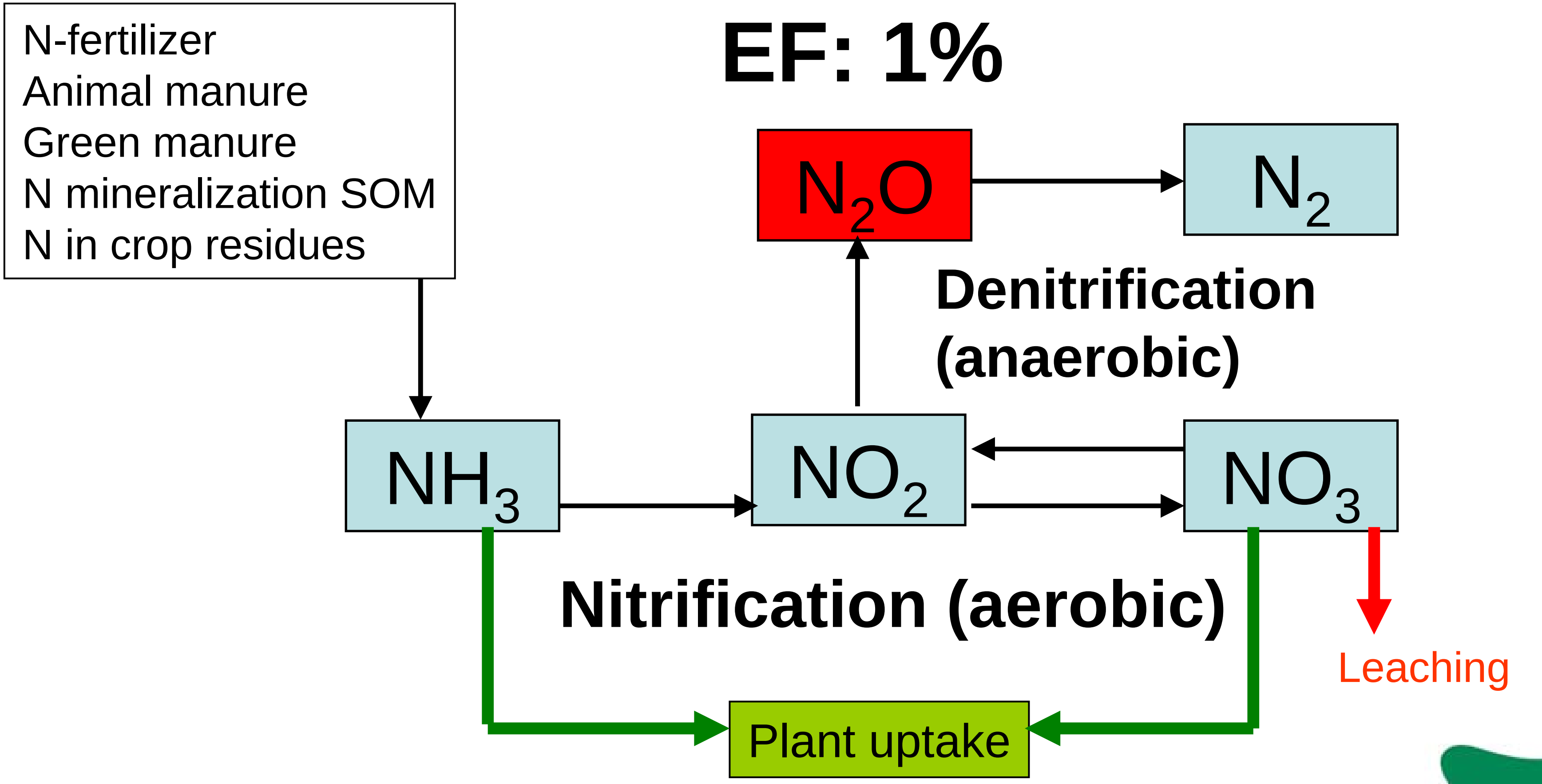
- Contributor – eg methane,N_2O
- Protector – eg soil C sequestration, bioenergy
- Victim – eg yield loss, production risk
- (Benefiter – increased yields)?

GHG emissions from Swedish agriculture ($\text{mill tons } CO_2 \text{ equiv}$)

- N_2O from nitrogen cycling in soils, incl N-fertilizers and animal manure: **5.2 mill tons**
- CH_4 livestock and manure: **3.3 mill tons**
- Energy in agriculture: **> 1 mill ton**
- Change in land use, eg organic soils: **some mill tons**

Naturvårdsverket, 2007, 2009
Hushållningssälskabet Halland, 2009

Emission of N_2O from soils

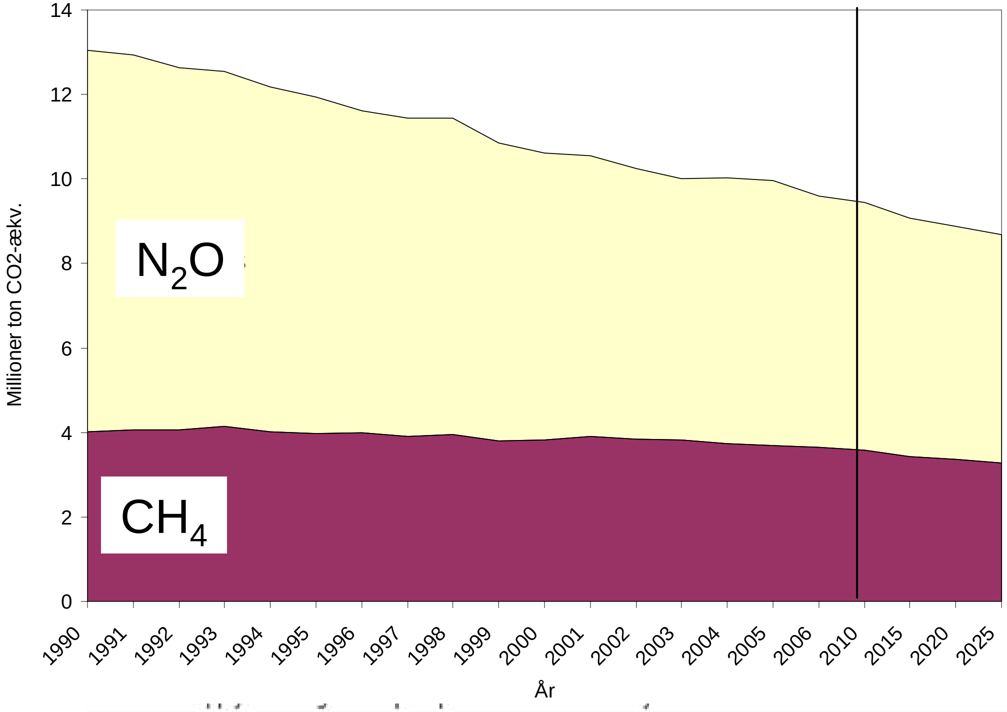


Reduction of N_2O emission from soil

- Avoid accumulation of nitrate in soil **OF ☺**
  - Permanent plant cover (catch crops) **OF ☺ ?**
  - Split application of fertilizer
  - Nitrification inhibitors
  - Efficient uptake and use of N in crops
  - Biologicial N_2 fixation **OF ☺**
- Reduced incorporation of crop biomass with high N content (e.g. clover) **OF- 😐**
  - Harvest of such biomass (catch crops, green manure) to be used in biogasproduction

Olesen, 2007

Synergy

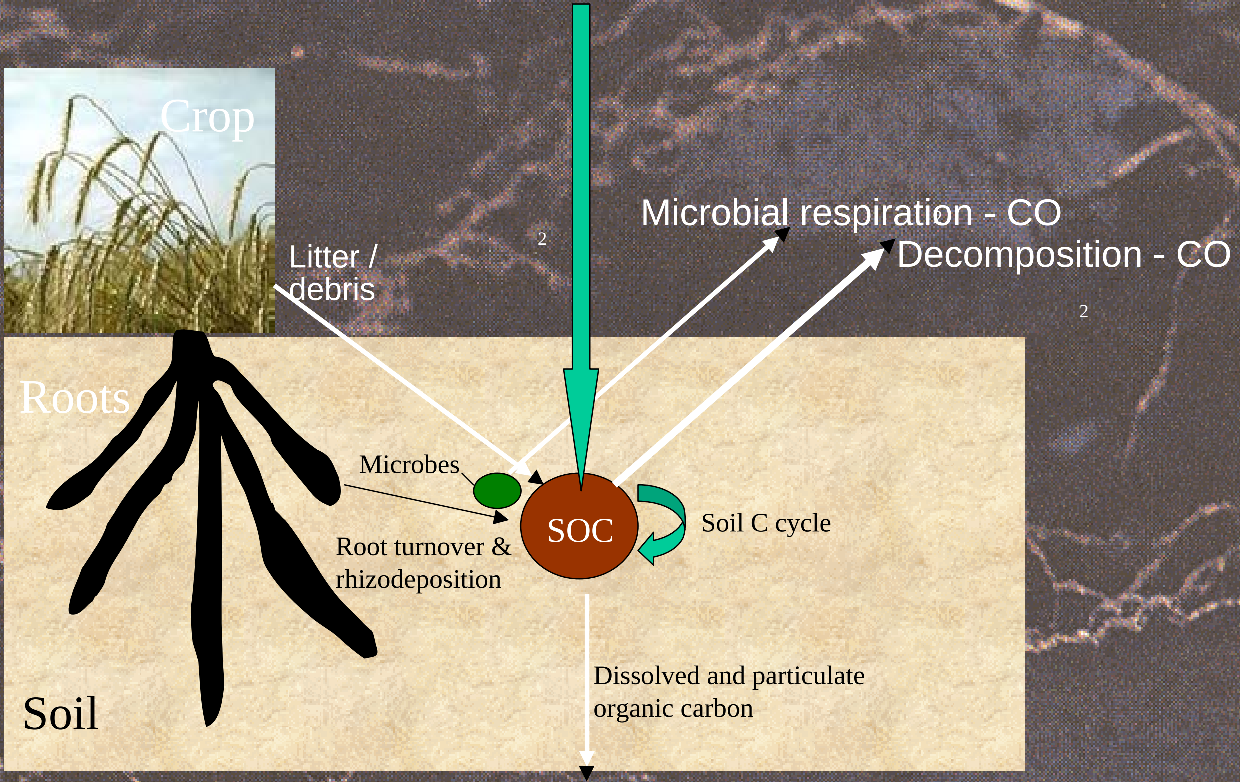


Development in Danish emission of GHG
N_2O and CH_4 (mill t CO_2equiv)
Projected to 2025

Development in Danish use of N and P fertilizer and N/P in animal manure

The soil carbon cycle – sequestration and turnover

Factors affecting SOC turnover:



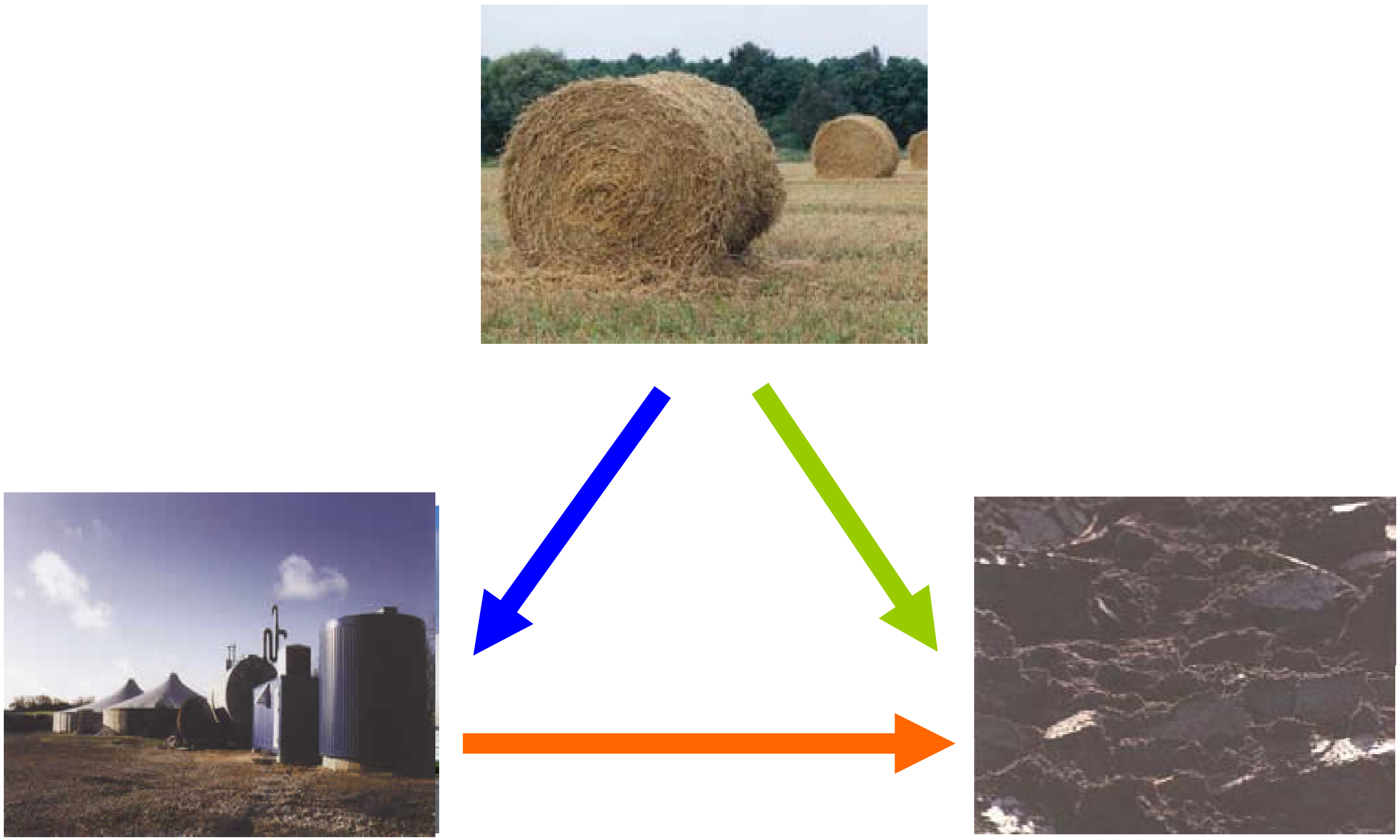
Factors:
Temperature,
Moisture
pH
Nature and quantity of C input
Tillage

J. E Olesen, 2008

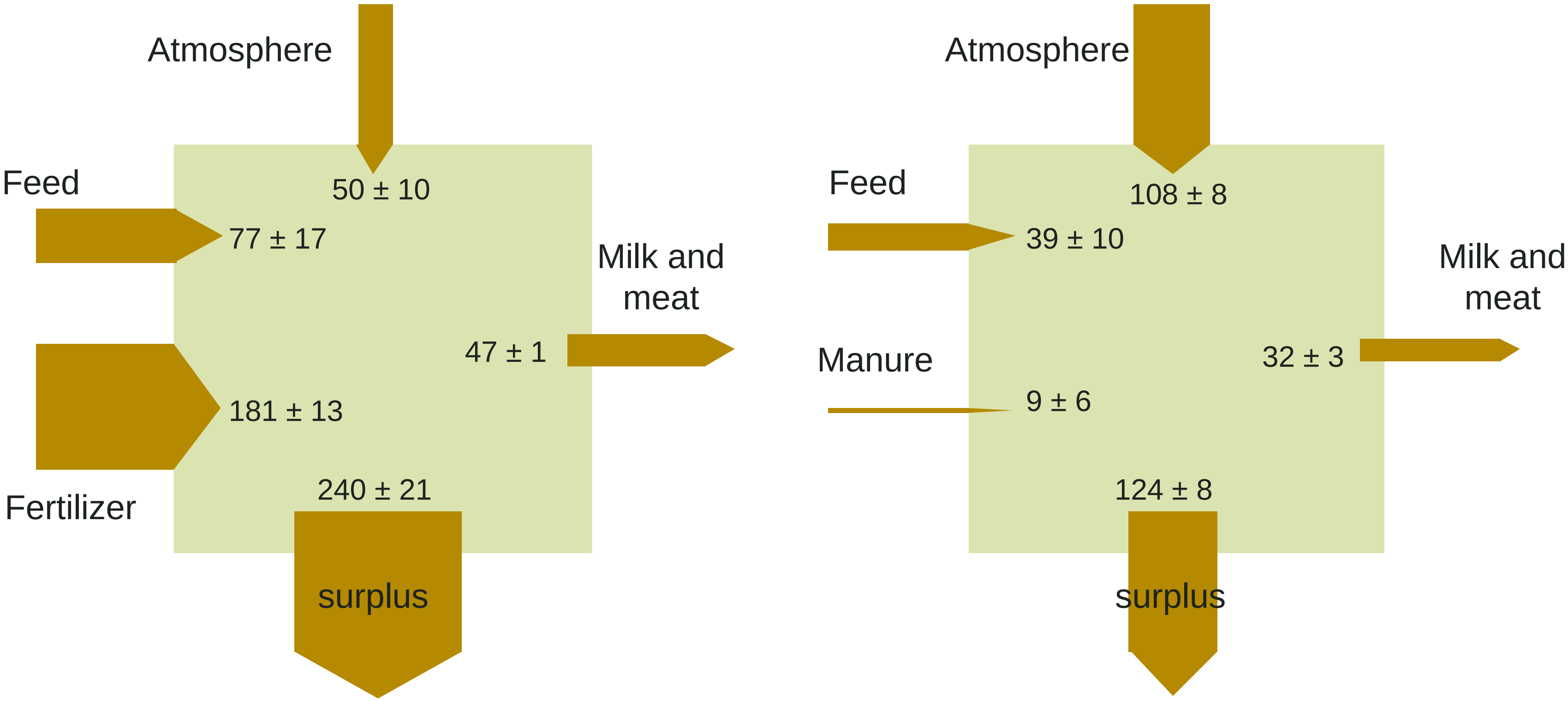
Reduction of CO_2 emissions from soils

- Increase carbon sequestration in mineral soils **OF** ☺
  - Increase incorporation of carbon rich crop residues, catch crops, animal manure, etc. **OF** ☺
  - Reduced soil tillage
- Stop drainage and cultivation of organic soils

What role for organic farming in mitigating climate change?



Nitrogen balance in Danish conventional and organic milk production

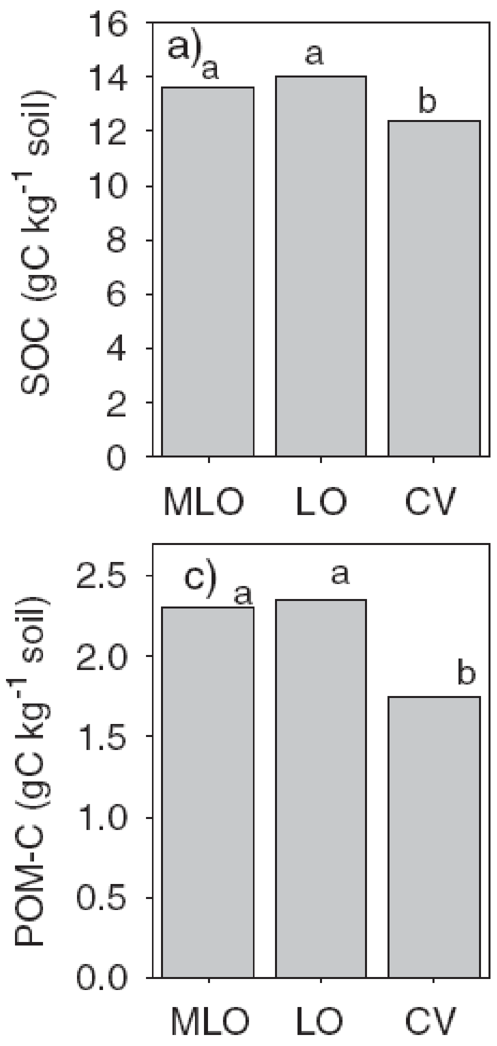


Conventional milkproduction

Organic milkproduction

Dalgaard et al 1998

Soil C sequestration and quality



Marriot and Warner, 2007
9 long-term studies US (SSAJ)

Organic systems compared to conventional:

•Soil organic carbon ↑

•Particulate organic matter ↑

•Microbial biomass ↑

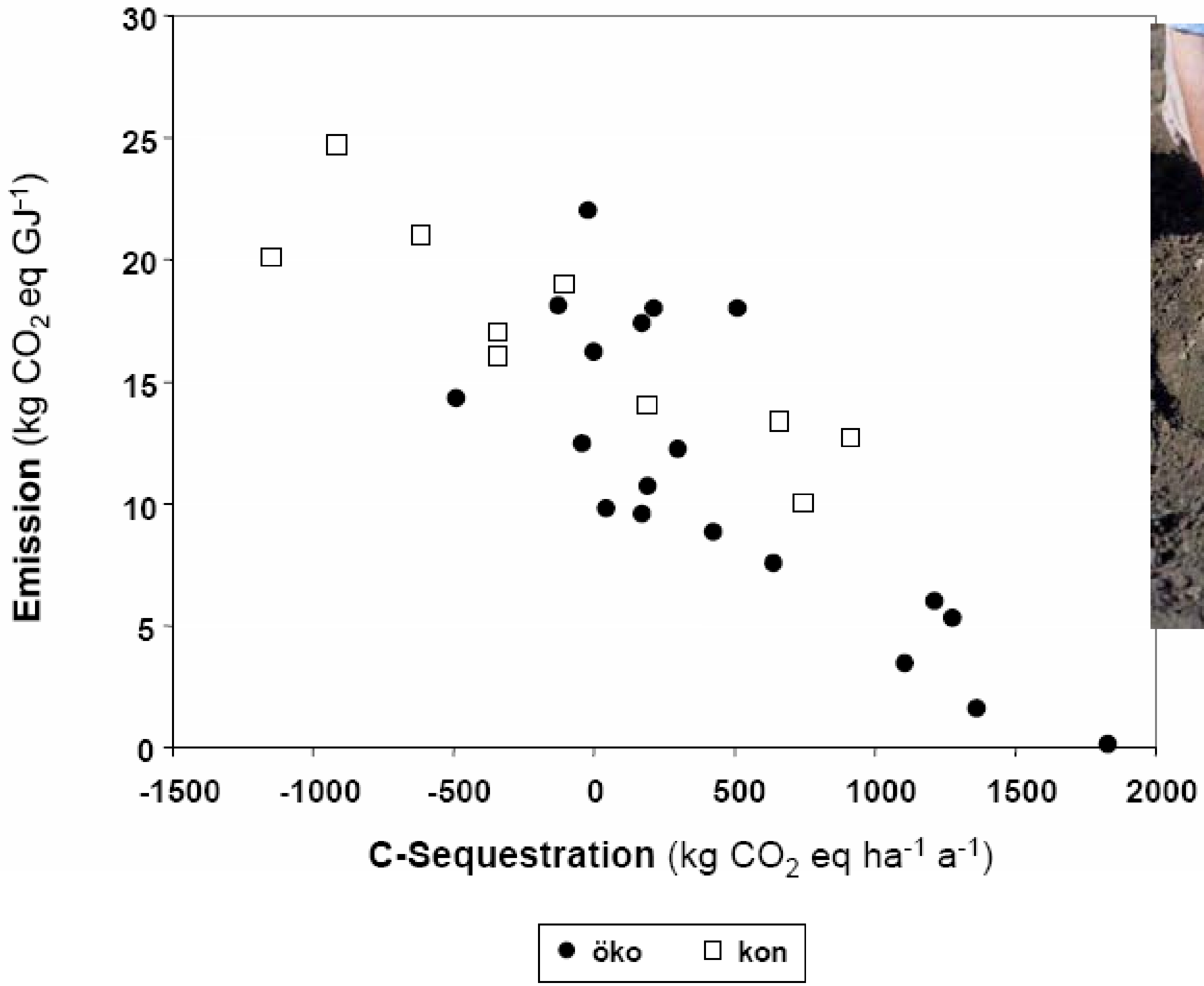
•Soil erosion↓

•Top soil depth ↑

Many studies published in peer-review journals indicating 30-50% improvement in organic system in long-term experiments

MLO: manure+legume organic
LO: legume organic
CV: conventional

Carbon sequestration and GHG emissions (CO_2/kg product)



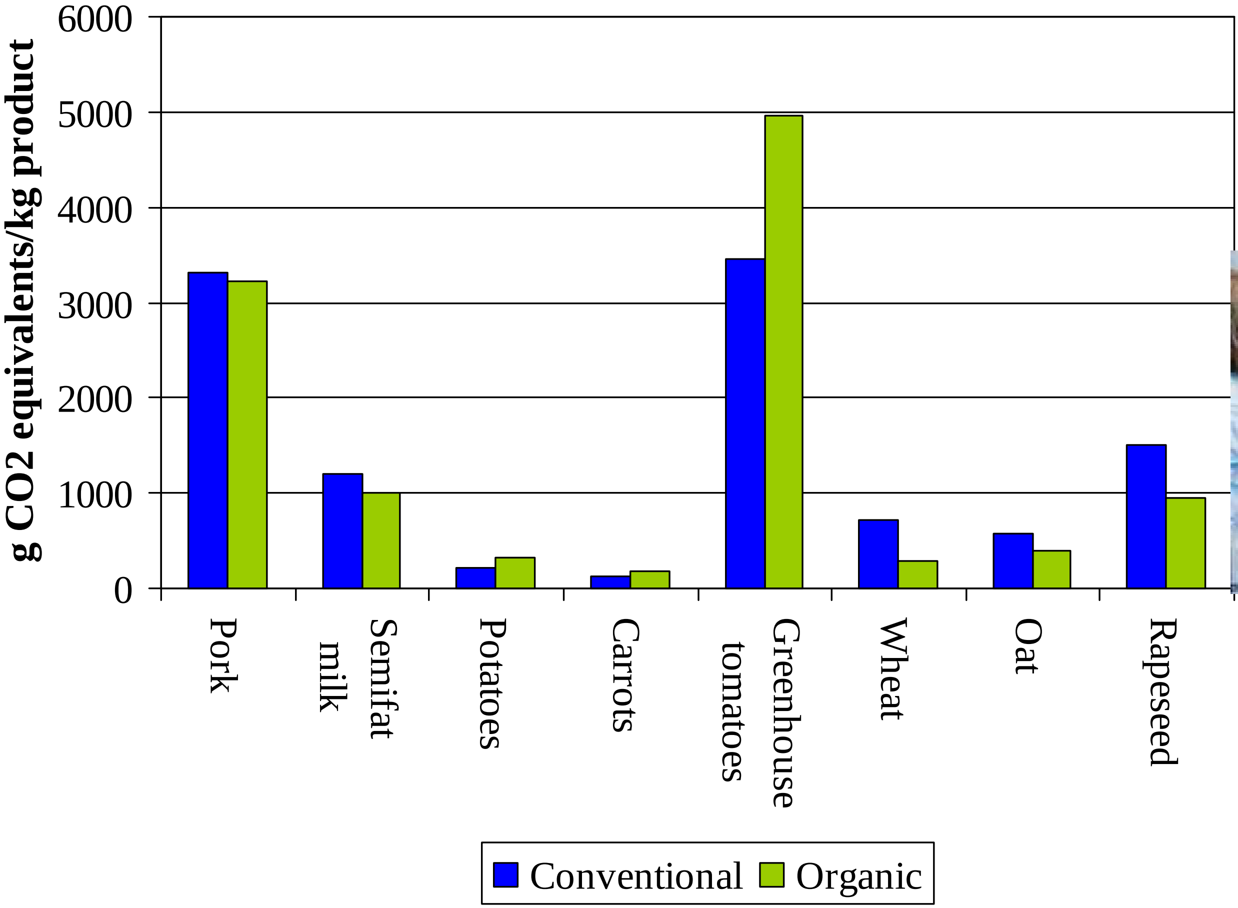
Kustermann and Hulsbergen, 2007

Fossil energy efficiency in milk and crop production

MJ per kg product	Conventional	Organic
Grass-Clover	2.0	0.7
Spring Cereal	2.4	2.0
Milk	3.3	2.7

Refsgaard, Halberg og Kristensen, 1998

Organic products may not be very different from conventional in GHG emission/kg



ICROFS 2008

Summary - role of OF in mitigation

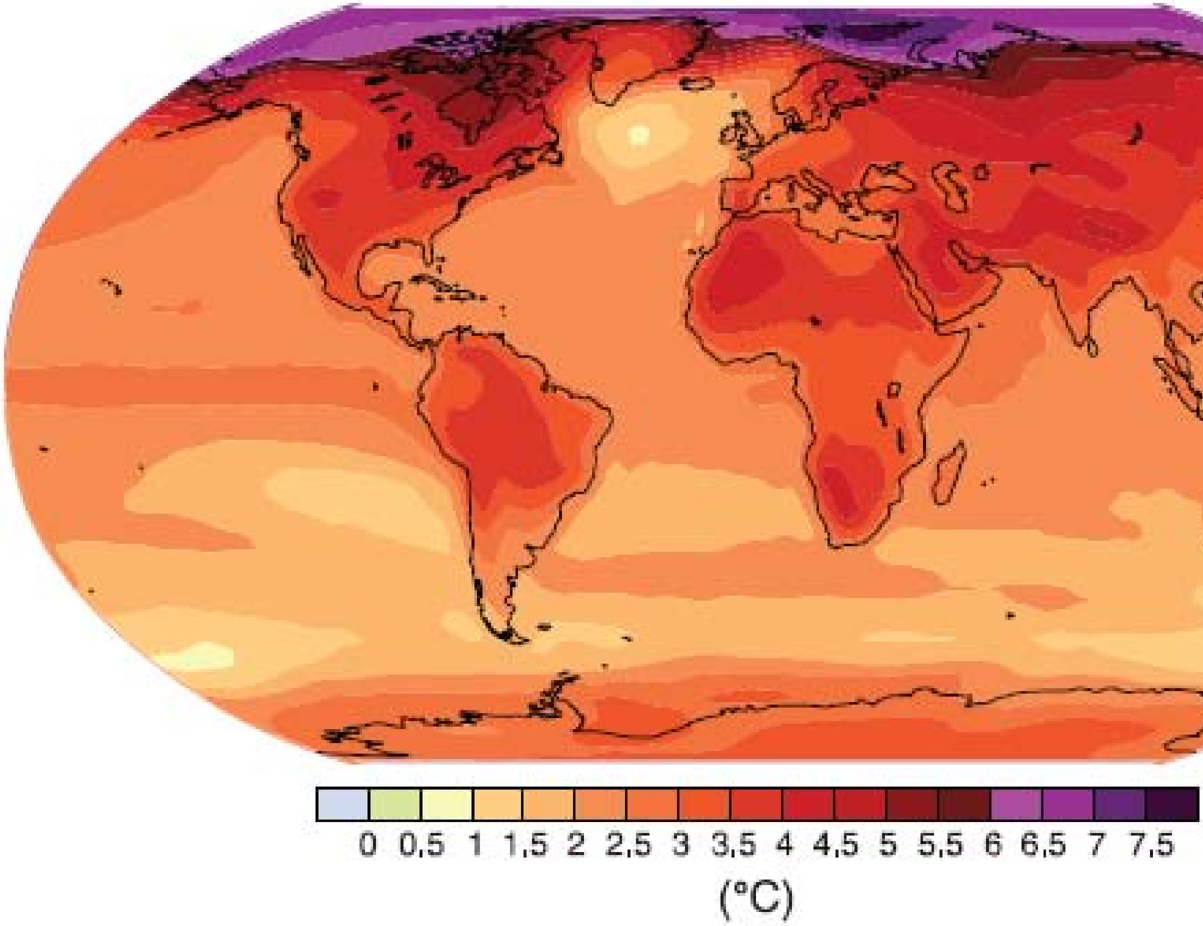
- + Reduced levels of N in systems reduces risk of N_2O emissions
- + No synthetic N fertilizer is used (fossil energy saving)
- + More organic matter is added and sequestered in soils, due to perennial grass crops and animal manure
- + Higher organic matter increase fertility and ability to preserve water

- - lower yields (20-50%)
- - animal manure from grazing animals
- - mechanical weeding requires fossil fuels

R & D – short and longer term (mitigation)

- **Short terms**
  - Increased efficiency in use of nutrient s animal manure and crop residues
  - Develop biogas production on farm and more farm based renewable energy technologies
  - Integration of energy crops in rotations
  - How to reduce cost of GHG emission reduction?
  - Save fossil energy
- **Longer term**
  - New cultivars with higher N use efficiency and N_2 fixation capacity
  - Increased integrity
  - Cropping systems with permanent crop cover
  - Cropping systems without soil tillage
  - Enhanced yield - eco-intensification
  - Technologies for treatment of animal manure without release of GHGs

Expected changes in surface temperature 2100



IPCC, 2007

CC consequences for Swedish agriculture

- Longer growth season
- Increased and new pests and diseases
- Damage of heavy rain on crops and flooded soils out of production – increased leaching of nutrients

- More erosion
- Increased yields?
- New crops and cultivars possible and required
- + Long rotations with different species in OF will spread the risk due to radical weather incidents

Suggestions for R & D (Adaption)

- Which crop species, cultivars and rotations in which region?
- Water efficiency
- How to reduce erosion in annual crops?
- Which new diseases, weeds, pest will be most important in organic farming?
- Which new preventive and curative methods will be required and which new plant protection strategies are required in OF?
- Will increased diversity in both time and space of cropping systems reduce risks further?
- Which extreme weather conditions can be expected and how can organic farming prevent damage?
- Which cropping system will be the most resilient to extreme weather incidents

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Conclusions

- Organic farming needs to reduce GHG emissions and/or increase yields
- Organic farming offers an efficient method of soil C sequestration due to rotations with pastures and animal manure
- Biogas production to be integrated
- Organic farming needs to start adapting to climate change via new cultivars
- Fossil energy savings in the whole food cycle