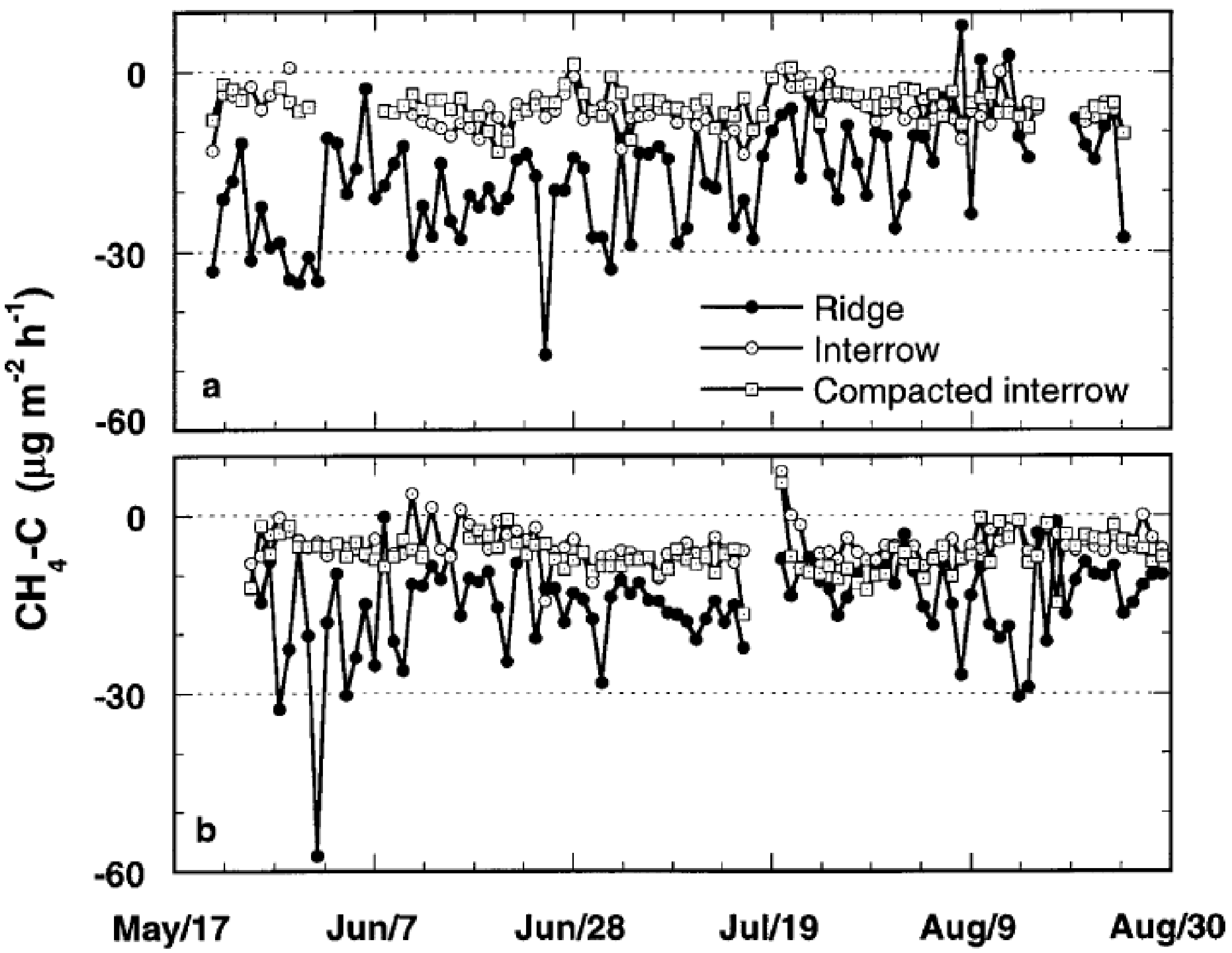
Arable, grassland and forest soils (= upland soils) are a sink for atmospheric methane through methane oxidation (eg. potato field)

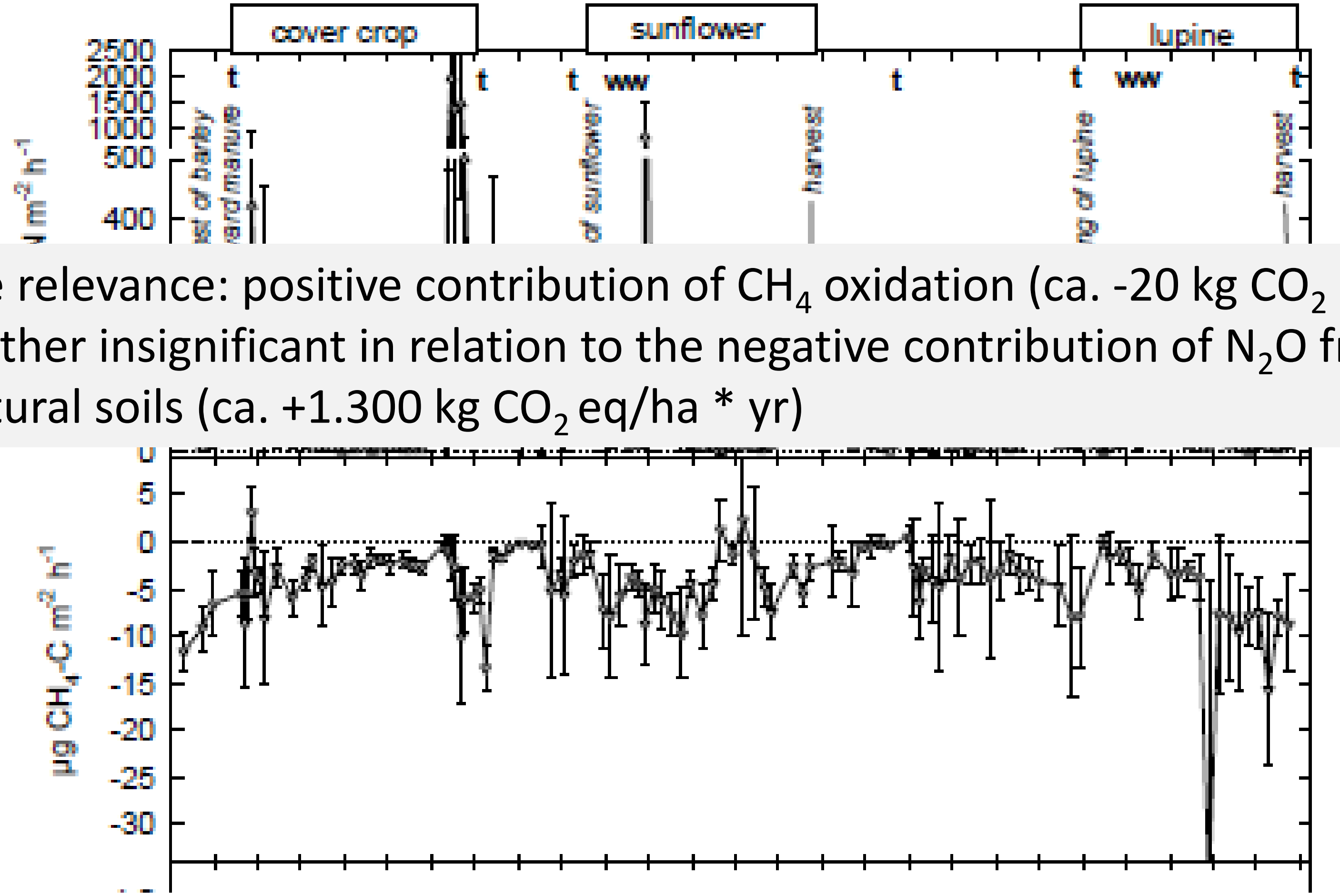


1997

1998

Flessa et al., 2002

Methane and nitrous oxide fluxes in arable soils



Climate relevance: positive contribution of CH_4 oxidation (ca. -20 kg CO_2 eq/ha * yr) is rather insignificant in relation to the negative contribution of N_2O from agricultural soils (ca. +1.300 kg CO_2 eq/ha * yr)

Dörsch, 2000

CH_4 oxidation in soils

Proximal controls

- CH_4 availability
- Soil water <-> O_2 content
- Availability of ammonium and nitrate in soil solution (Inhibition of CH4 oxidation through NH_4^+ or NO_3^-)
- Temperature

Less CH_4 (or more CH_4 oxidation) from/in organically managed soils?

	CH_4 fluxes per acreage (kg CH_4-C ha^{-1} a^{-1})					CH_4 fluxes per acreage (kg CO_2-eq. ha^{-1} a^{-1}) [f]					CH_4 fluxes per yield (kg CO_2-eq. t^{-1} DM)				
land-use	MD [a]	CI [b]	p	studies	comp. [c]	MD [a]	CI [b]	p	studies	comp. [c]	MD [a]	CI [b]	p	studies	comp. [c]
arable	-0.09	0.20	0.06	3	8	-3.1	3.3	0.06	3	8	-2.12	2.15	0.05	2	5
rice-paddies	10.55	4.77	0.00	1	3	1097	242	0.00	1	3	156.0	31.8	0.00	1	3

Only few studies, related to area and yield increased methane oxidation in organically managed soils, but increased methane emission from organically managed rice paddies.

Skinner, Gattinger et al., STOTEN, submitted

What is most effective in GHG mitigation in crop production?

land-use		N_2O fluxes per acreage (kg N_2O-N ha^{-1} a^{-1})				GWP [c] N_2O fluxes per acreage (kg CO_2-eq. ha^{-1} a^{-1})				GWP
		Mean	SD	studies	treatments	Mean	SD	studies	treatments	
all (annual) [a]	org	2.71	1.02	12	44	1270	476	12	44	
	non-org	3.14	1.15		58	1437	536		58	
arable	org	2.58	1.00	11	41	1209	470	11	41	
	non-org	2.97	1.00		55	1392	468		55	
grassland	org	3.22	0.85	2	3	1[illegible]07	398	2	3	
	non-org	5.64	2.52		3	26[illegible]3	1118		3	
rice-paddies	org	0.89	0.16	1	3	41[illegible]	76	1	3	
	non-org	2.28	0.30		3	106[illegible]	142		3	
overall [b]	org	5.33	4.60	18	64	2497				
	non-org	6.68	4.57		79	3120				

= a saving of ca. 4.0 Mg CO_2 eq ha^{-1} y^{-1}

land-use		CH_4 fluxes per acreage (kg CH_4-C ha^{-1} a^{-1})				GWP CH_4 fluxes per acreage (kg CO_2-eq. ha^{-1} a^{-1})			
		Mean	SD	studies	treatments	Mean	SD	studies	treatments
arable	org	-0.61	0.13	3	3	-[illegible]0.2	4.2	3	3
	non-org	-0.54	0.11		8	-[illegible]8.0	3.6		8
rice-paddies	org	180.68	27.29	1	3	6023	910	1	3
	non-org	145.70	7.23		3	4857	241		3

What is most effective in GHG mitigation in crop production?

A few thoughts….

- Conversion from wetland to upland rice production (saving of 4.0 Mg CO_2 eq ha^{-1} y^{-1})
- Restoration of farmed organic soils (saving of 10.0 Mg CO_2 eq ha^{-1} y^{-1}; Freibauer et al., 2004), *restricted agricultural utilisation*
- C sequestration by conversion to OF (saving of 1.7 Mg CO_2 eq ha^{-1} y^{-1}; Gattinger et al., 2012), *not permanent, less yield*
- C sequestration by adoption of reduced tillage (saving of up to 1.0 Mg CO_2 eq ha^{-1} y^{-1}) *not permanent*
- N_2O mitigation by conversion to OF (saving of 0.5 Mg CO_2 eq ha^{-1} y^{-1}; Gattinger et al., 2012), *less yield*
- N_2O mitigation by site-specific fertilisation (saving of up to 30%; Sehy et al., 2003)
- C seq. and N_2O mitigation by converting to OF along with reduced tillage and site-specific fertilisation,…

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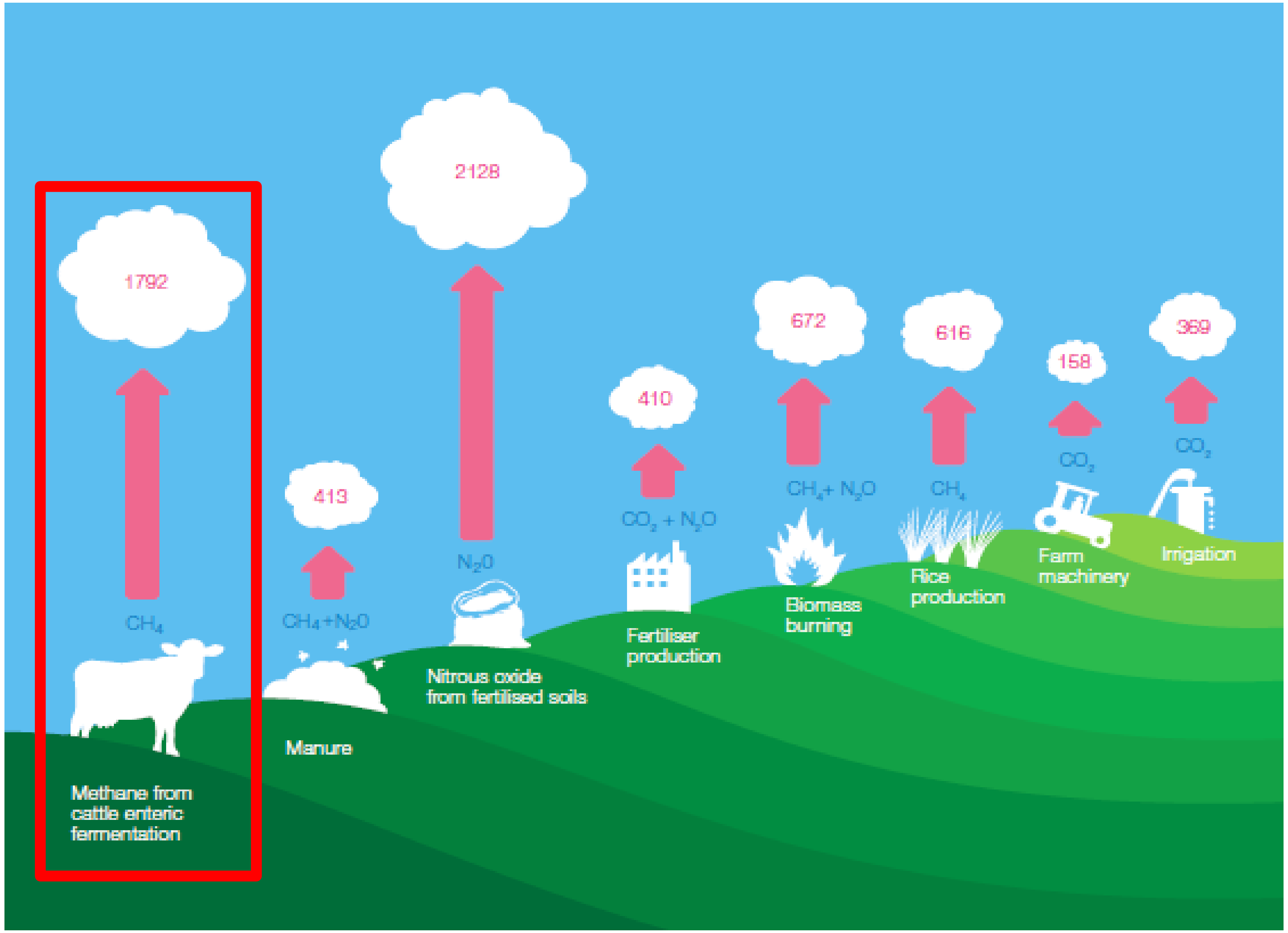
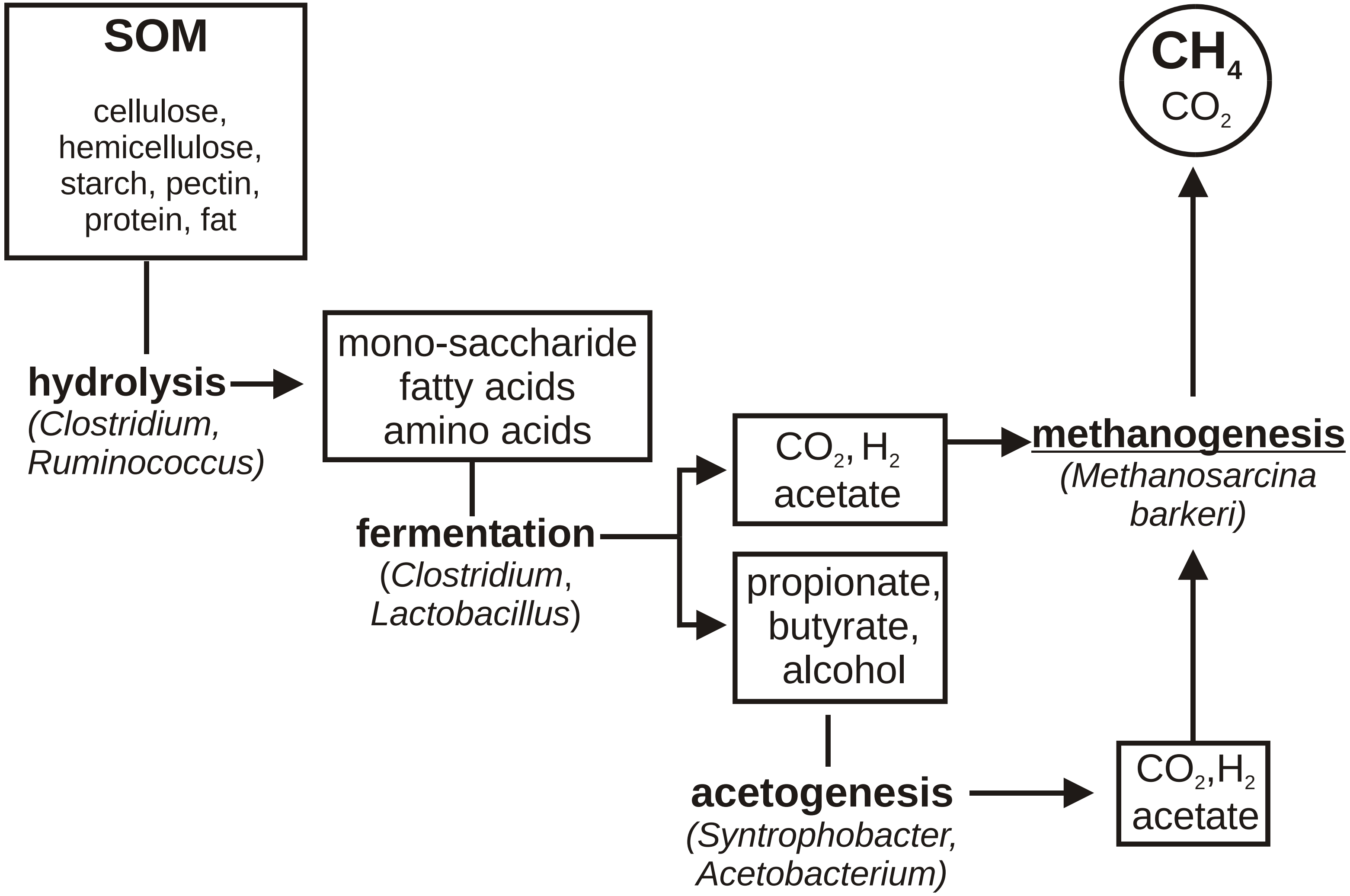
- Background
- GHG emissions and its mitigation potential in crop production
- GHG emissions and its mitigation potential in livestock systems
- The potential of organic agriculture to adapt to climate change
- Outlook for future agriculture

Agricultural greenhouse gases (without LULUCF)



Bellarby et al. 2008

The anaerobic metabolism: from cellulose to methane



Mitigating GHG emissions in animal husbandry

- Conventional approach
  - Intensification of production
  - Genetic improvement (more product units per animal)
  - Changing ruminal metamolism by additives and modified diets

- Sustainable approach
  - Physiological improvement of milk yield curves
  - Animal welfare aspects
  - Integrated herd health management
  - Optimized (not maximized) reproduction parameters

Animal health and climate protection

- General health improvement and longevity
- Udder health improvement
- Fertility improvement
- Rearing management

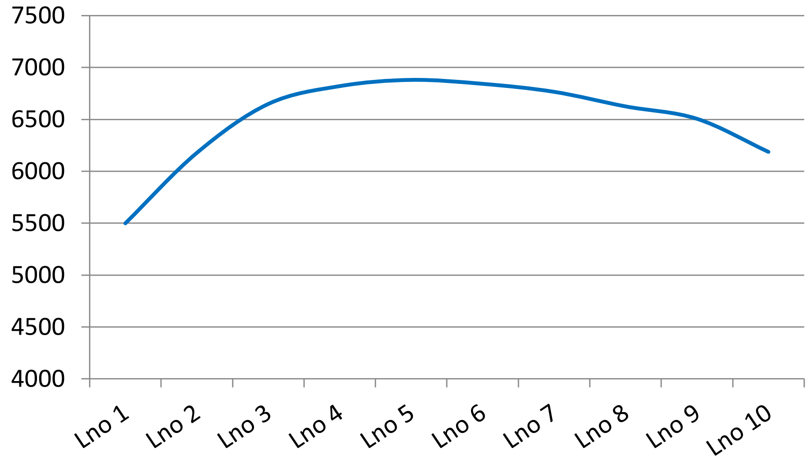
Health, Longevity and climate protection

- Replacement strongly depends on animal health
- Replacement intensity increases rearing days per farm
- Health improvement reduces culling rate
- Prolongation of LNo by 1 lactation leads to 23% less „unproductive“ days
- Milk yield optimum during 6th lactation!

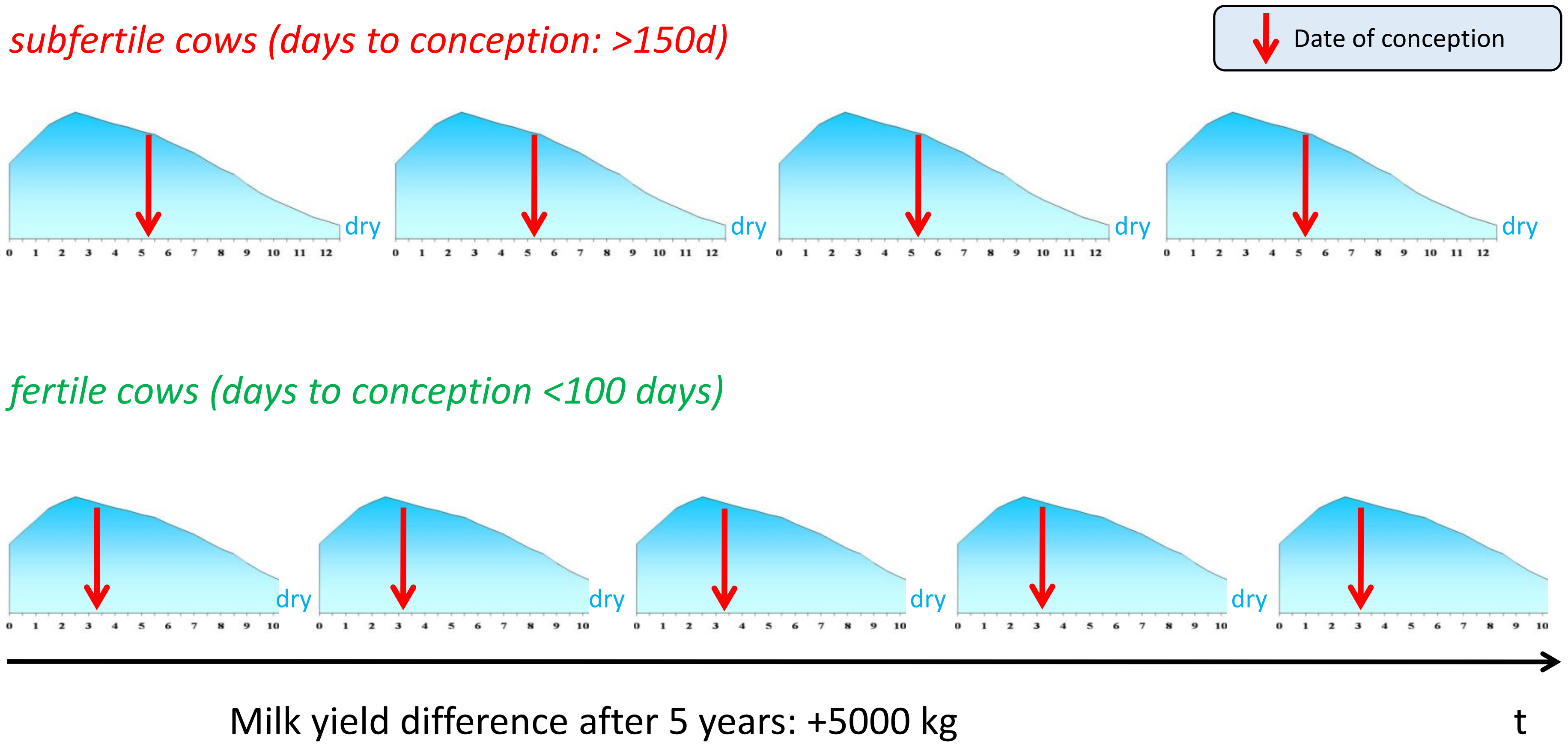
Impact of replacement intensity on „unproductive days“ during rearing period

	Ø CH	Increasing longevity	
Mean Lactation No	3.3	4.3	5.3
Replacement rate per year	~30%	~23%	~19%
„Unproductive“ days due to rearing* ** Age at 1st calving: 30 m*	**277/cow**	**212/cow (-23%)**	**173/cow (-38%)**

Milk yield (kg/cow) per 305 days by lactation number (data of FiBL project „pro-Q“)



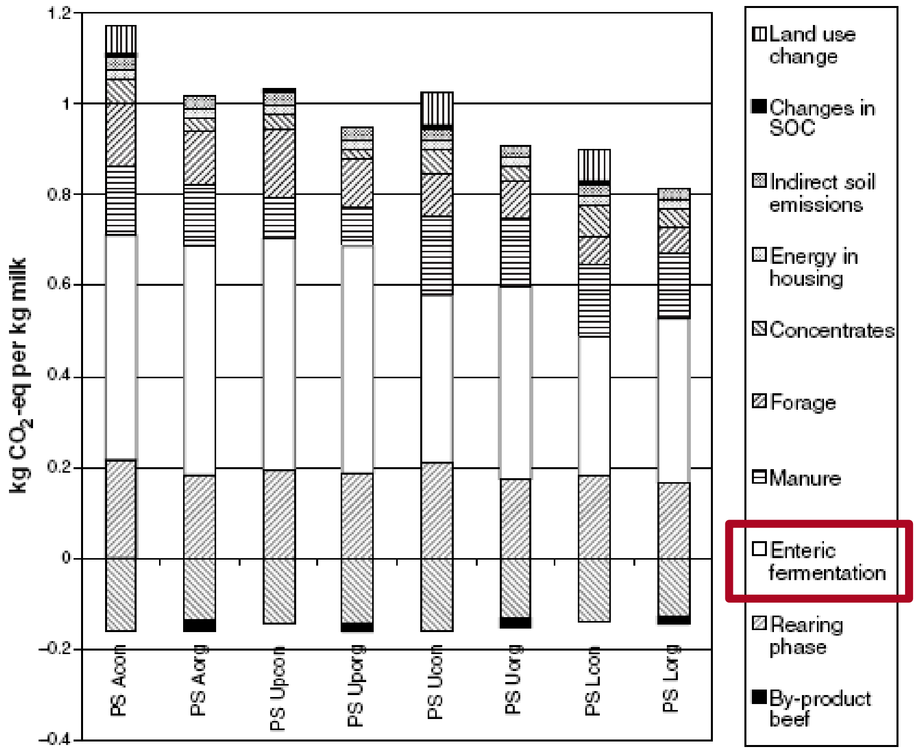
Lactation curves depending on fertility



Milk yield difference after 5 years: +5000 kg

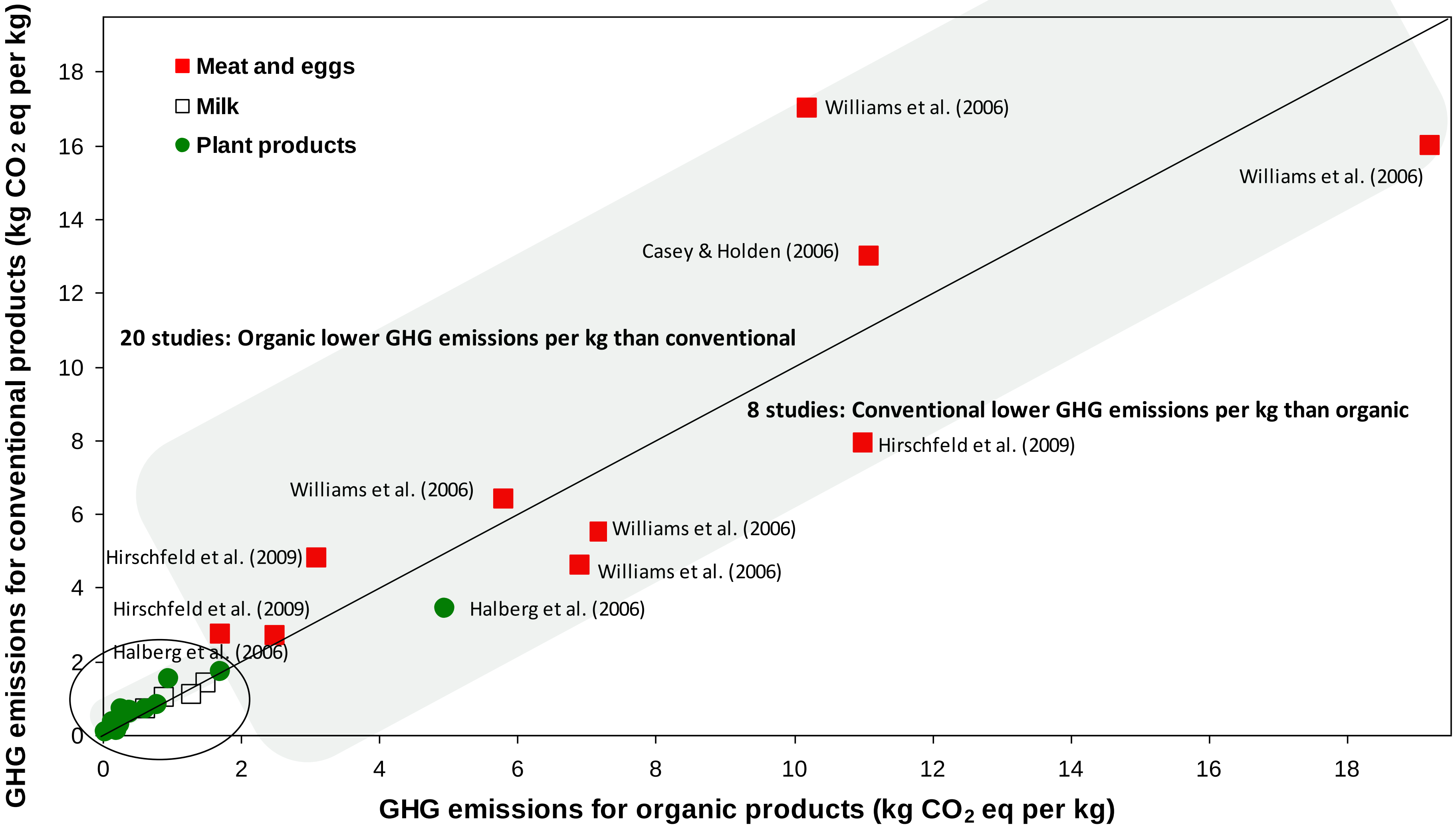
GHG emissions in cattle husbandry

- Very complex issue, requires LCA approaches
- also emissions resulting form manure management, fodder and concentrate production incl. LUC need to be considered.
- Lower GHG emissions per kg milk in organic dairy production in Austria.



GHGE (kgCO2-eq) per kg milk for eight Dairy production systems in Austria (Hörtenhuber et al., 2010)

Climate relevance of animal products



Knudsen et al., 2011

"Please eat less meat. Meat is a very carbon intensive commodity."

Rajendra Pachauri, Chair IPPC, Nobel Laureate 2007

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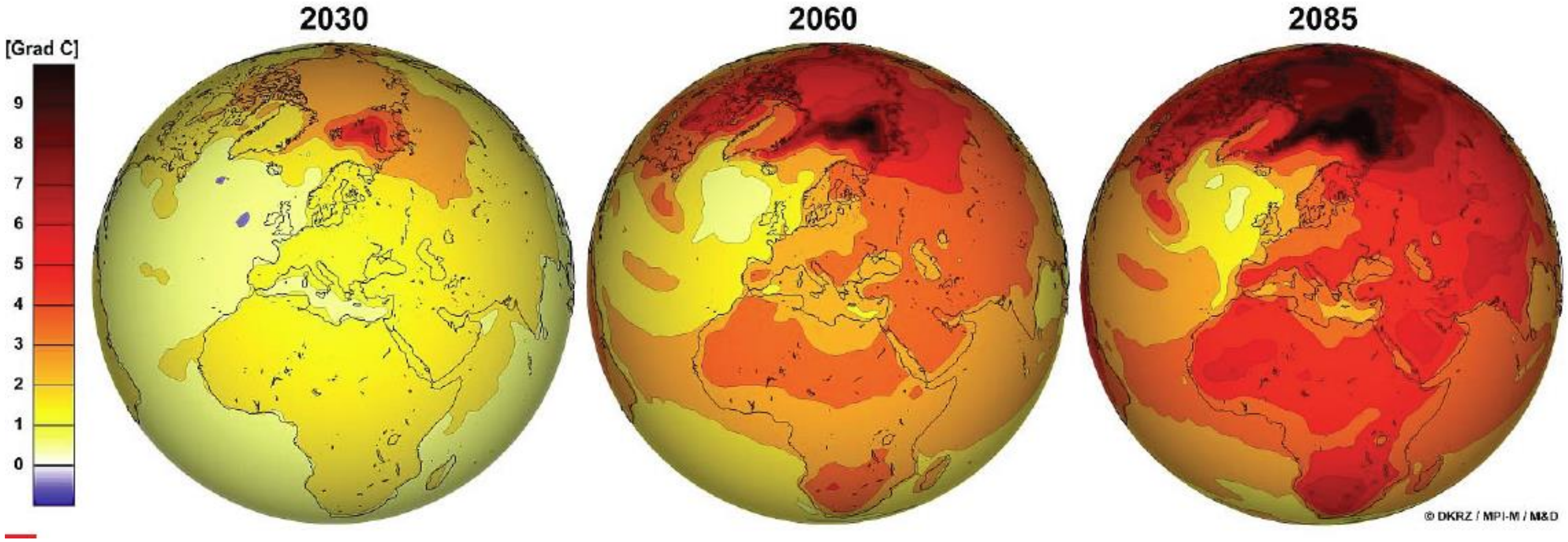
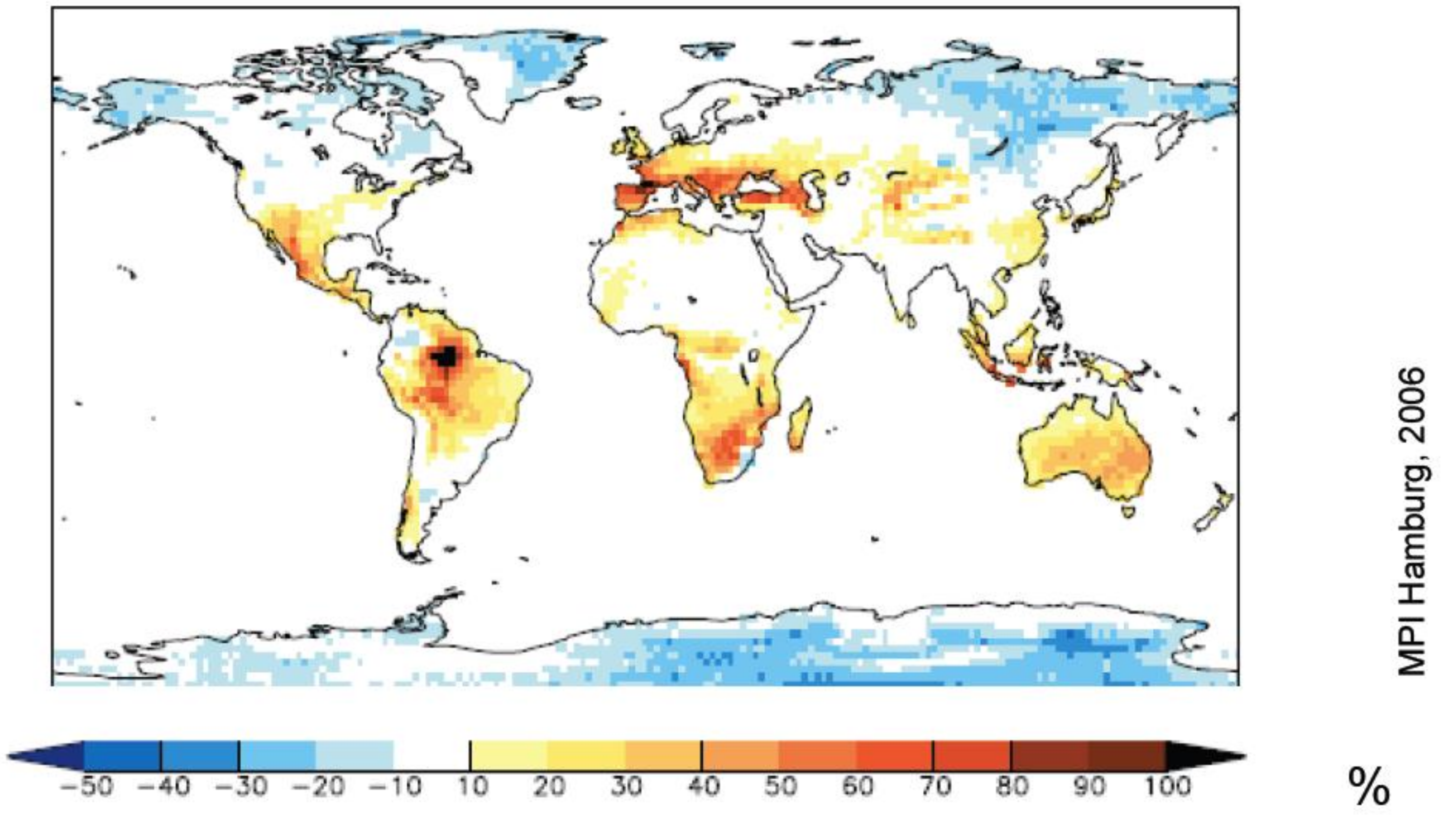
Estimated global warming



Simulierte Temperaturänderung mit ECHAM5 / MPI-OM: IPCC Szenario A1B

Estimated changes in dry periods



Change of maximum dry periods until 2071-2100 related to the years 1961-1990