EAAP Congress Kopenhagen 25.08.2014

Christian-Albrechts-Universität zu Kiel




Grassland for ruminant husbandry – International perspectives and globalisation

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New paradigm for agricultural production / research?

1. **“New challenges for Agricultural Research: Climate change, Food security, Rural development, Agricultural Knowledge Systems”**

   SCAR, European Commission, 2009; highlighting the new term **“Knowledge Based Bio-Economy”**

2. **“Food security”,**
   special section Science, 2010; highlighting the new challenge for agricultural research summarized in the term **“Sustainable Intensification”**, published first from the Royal Society in 2009 in the paper

3. **“Reaping the benefits – Science and the sustainable intensification of global agriculture”** (The Royal Society, London 2009)

4. **“The state of Food and Agriculture – Livestock in the balance”,** FAO, 2009

→ **new paradigm for agricultural research: “Sustainable intensification””**

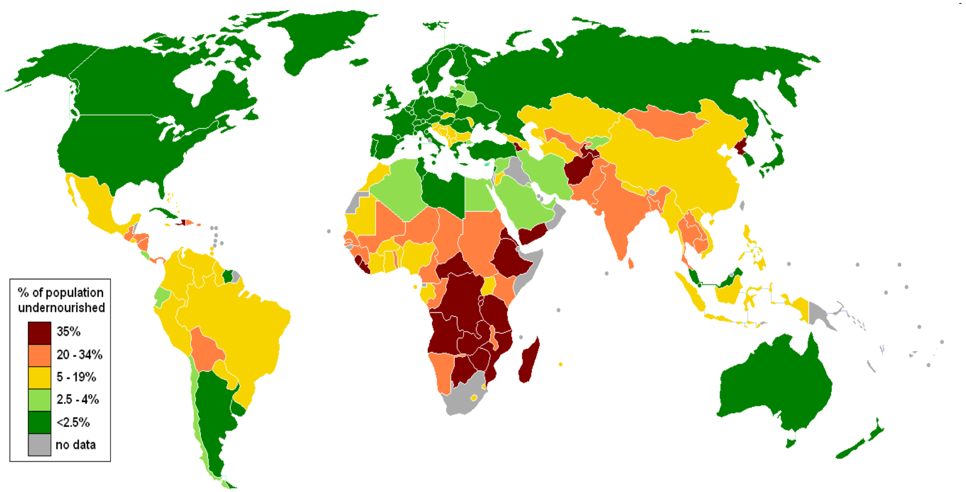
“Sustainable intensification”

- based on prognoses indicating nearly a doubled feed demand till 2050 (FAO, 2009); threats due to climate change, loss of biodiversity, eutrophication …

Encompassed by ethical and political issues:

- **The “double burden of male nutrition”**

- **30-40% of eatables not consumed,**
  - due to lack of infrastructure in the developing countries
  - due to waste in the industrial countries



- **Eco–efficiency:**

- The relationship between economic output (product, service, activity) and environmental impact added caused by production, consumption and disposal

- Functional unit: per product (e.g. kg ECM)

- > „ecological footprint"; LCA;
- > PCF (product carbon footprint)

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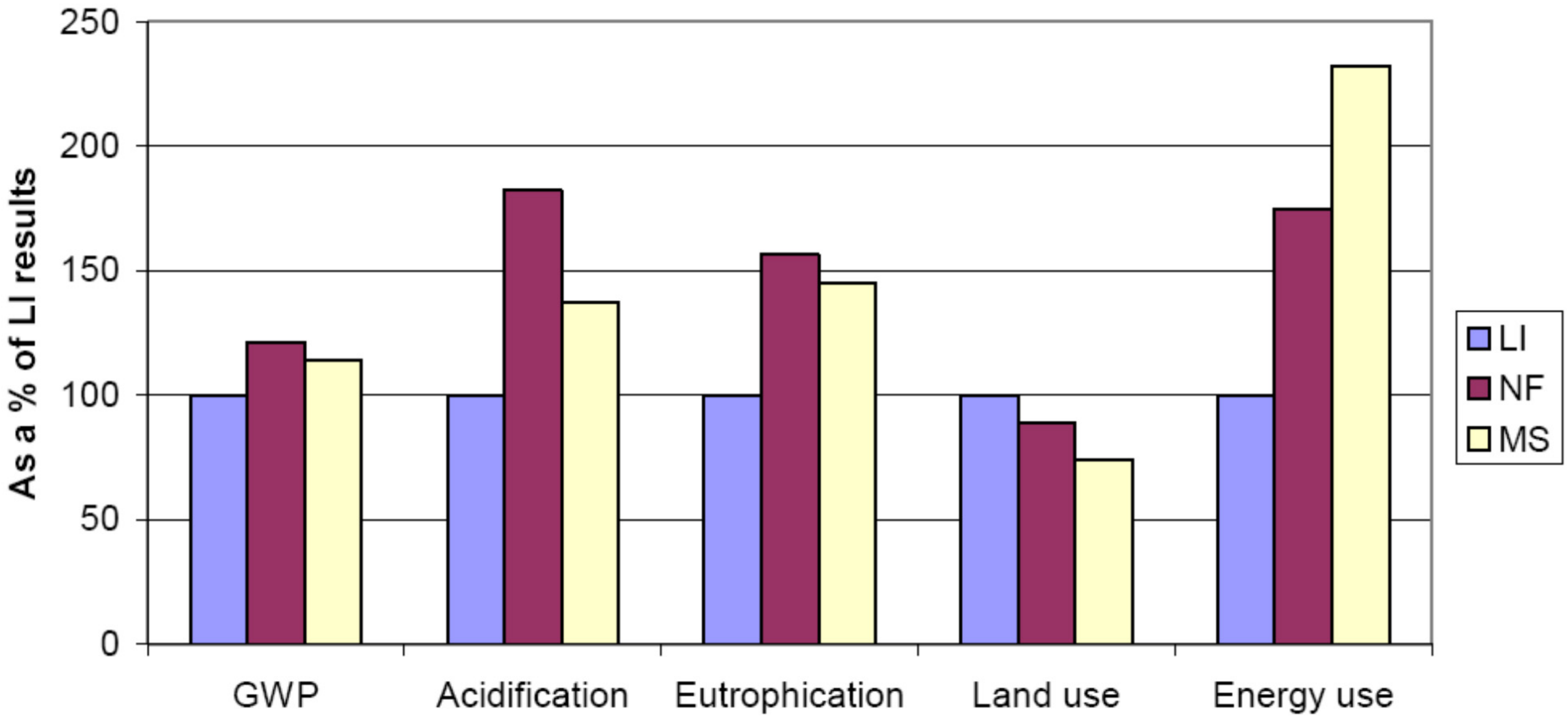
New Zealand: Impacts per kg of milk (Basset-Mens et al. 2006)



LI= Low input system (0 Nfert, 2.3 cows/ha);
NF= N fertiliser system (170 kg N/ha, 3 cows/ha);
MS= Moderate supplement system (170 kg N/ha, 13 tDM maize silage/ha, 5.3 cows/ha)

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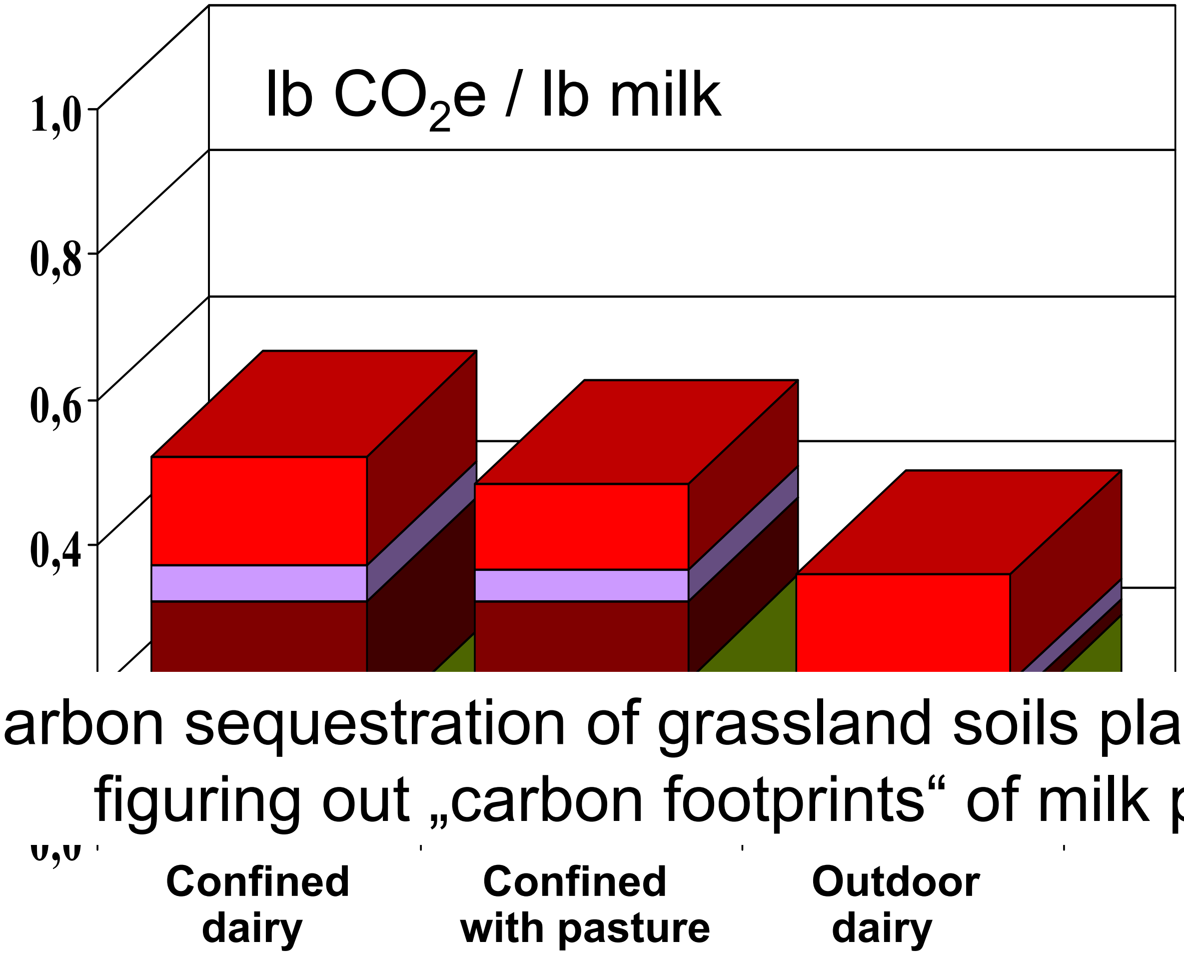
US: Carbon Footprint (incl. C-Sequestraton)

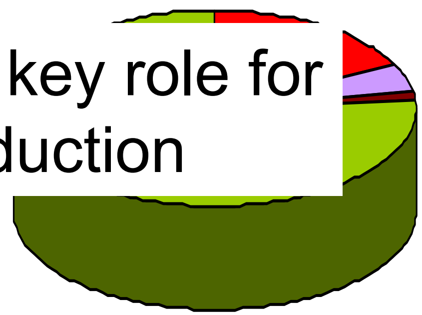
Source: Dawn Sedorovich, Al Rotz, IFSM simulations



Carbon sequestration of grassland soils play a key role for figuring out „carbon footprints" of milk production

Beef Footprint

5.8 lb CO_2e/ lb live weight



Forage: alfalfa/maize | mixed | grassland/pasture

A globalized feedstuff market

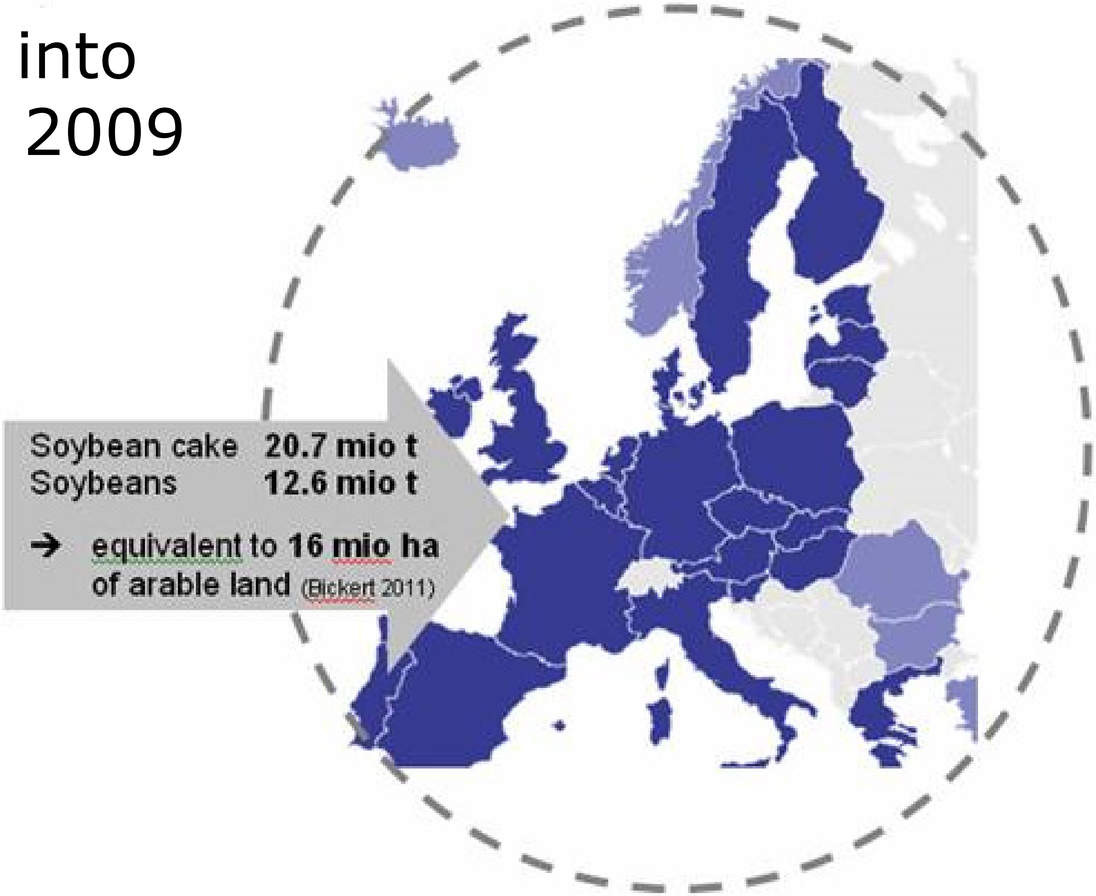
Using soy-based concentrates for dairy cattle nutrition increases milk production!

BUT

What are the environmental impacts of substituting homegrown proteins by imports?

Ecological footprint of milk production in Europe?

Soya imports into the EU(27) in 2009



60% of the consumed protein feedstuff EU > imported

(FAOSTAT, 2012)

Main drivers for GHG emissions in dairy systems

- Up to 80 % of the PCF milk can be determined by GHGs from feed production! (Flachowsky et al., 2011)
- GHG fluxes from forage production areas predominantly originate from:
  - N_2O (from fertilizer, manure, animal excrements, N leaching)
  - CO_2 (from C sequestration or C release)
- GHG emissions (in particular N_2O) from forage production areas are characterized by high spatial and temporal variability. (Senbayram et al., 2011)

PCF of milk production systems

- What are the differences in the PCF of milk produced in a high input confinement and a low input pasture-based system in northern Germany?
- How do globalized feedstuff markets affect PCF‘S?
- What are the major methodological constraints?

Background:
Protein gap in Europe > LUC Latin America > dairy system?

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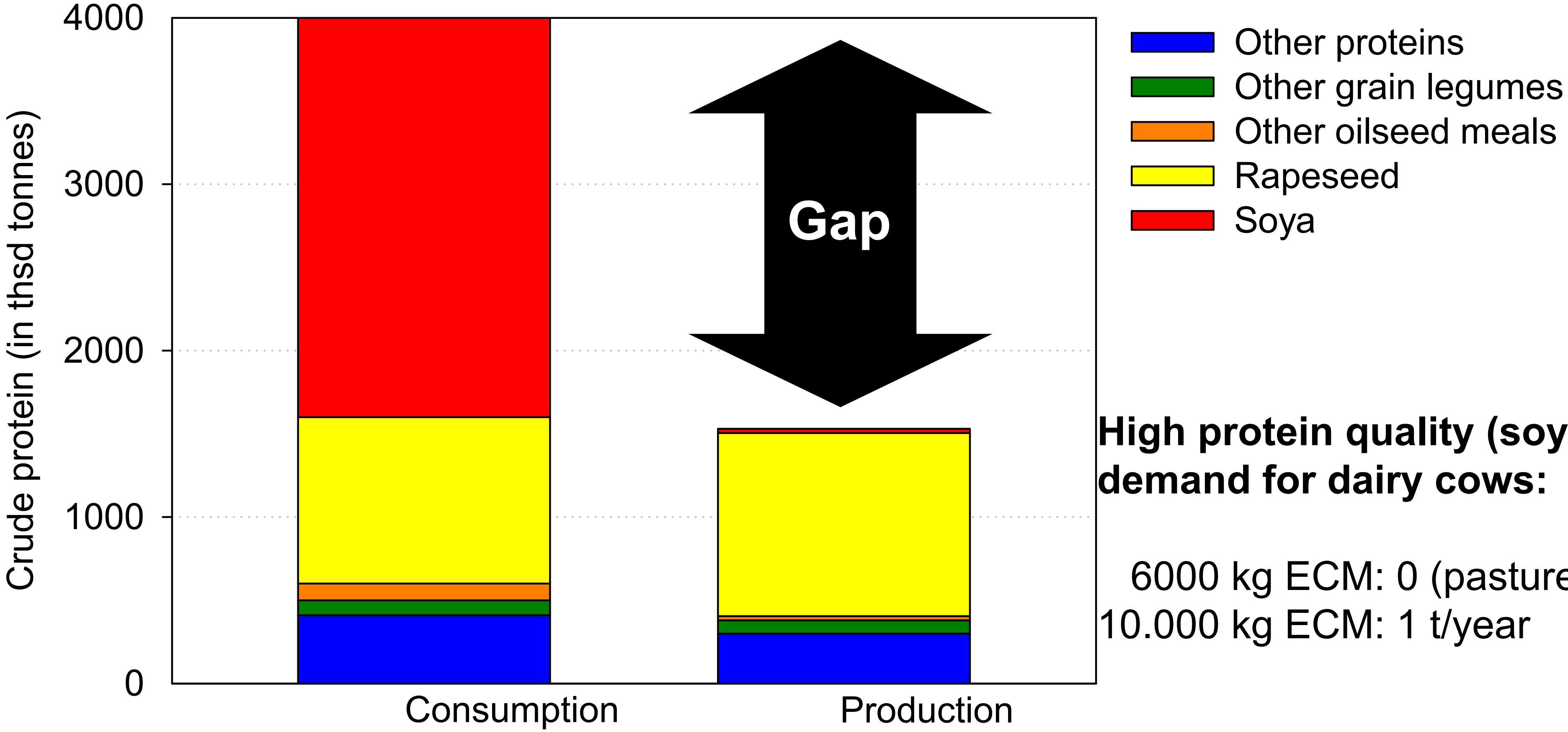
Consumption and production of protein feeds in Germany (2006-2010)



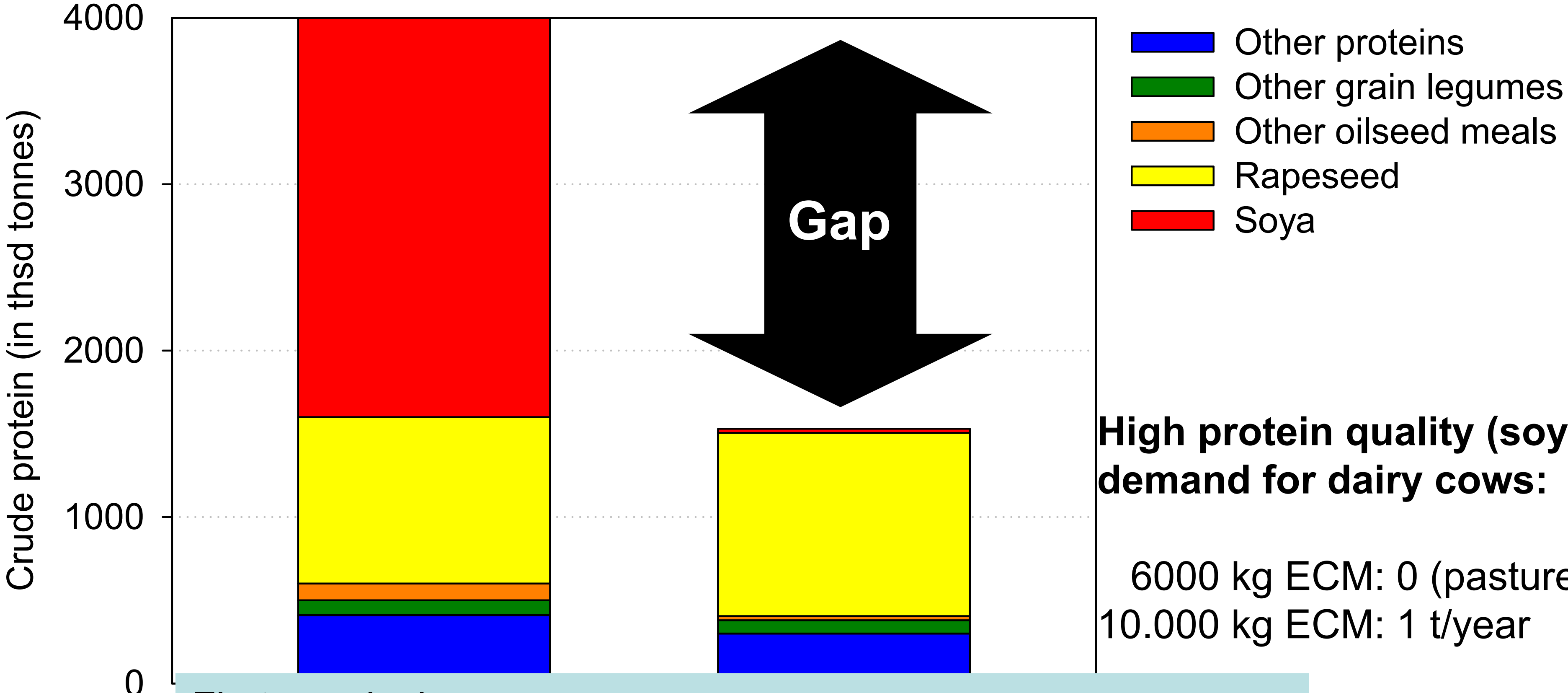
(Stockinger & Schätzl, 2012)

High protein quality (soy) demand for dairy cows:

6000 kg ECM: 0 (pasture)
10.000 kg ECM: 1 t/year

Soy import EU: 30 Mio t/year; equivalent to 16 Mio ha

Consumption and production of protein feeds in Germany (2006-2010)



High protein quality (soy) demand for dairy cows:

6000 kg ECM: 0 (pasture)
10.000 kg ECM: 1 t/year

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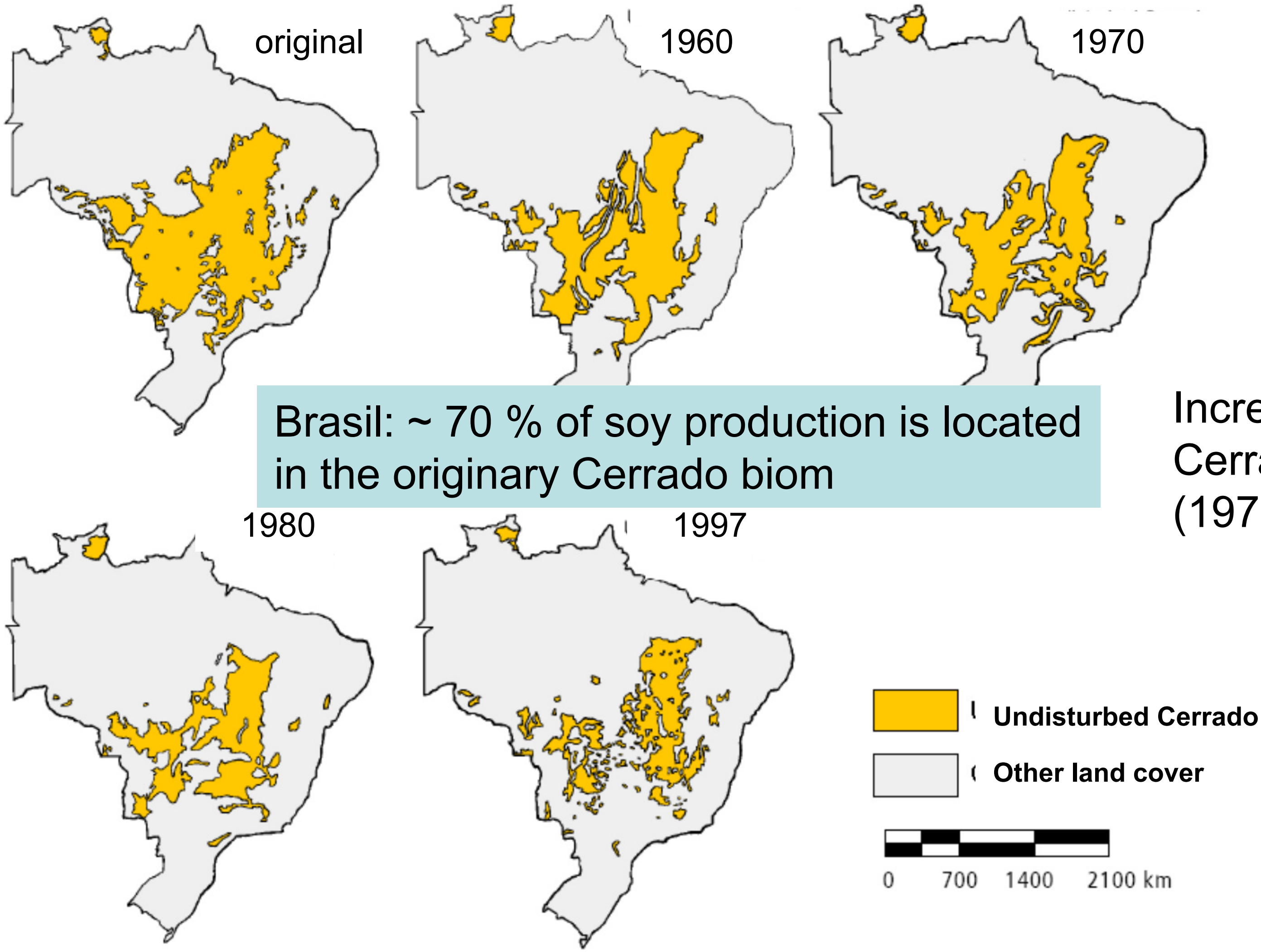
First conclusion:
European high input dairy systems contribute to the European protein gap due to soy imports from Latin America –
What are the consequences regarding LUC in Brasil?

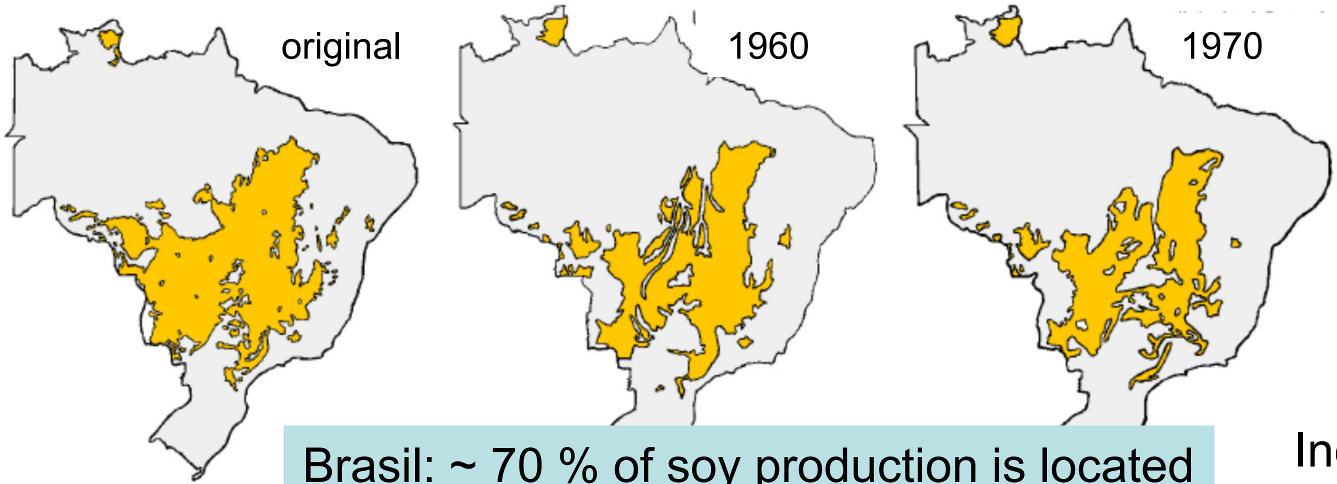
Development of agriculture in Cerrado/Brazil



Brasil: ~ 70 % of soy production is located in the originary Cerrado biom

Increase of soybean area in Cerrado: 10 Mio. ha (1970 – 2000) Fearnside, 2001

Development of agriculture in Cerrado/Brazil



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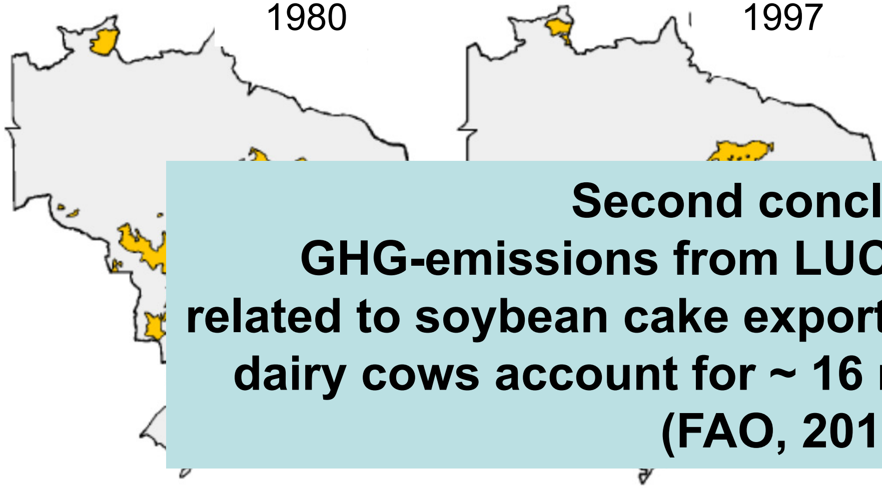


Second conclusion:
GHG-emissions from LUC in South America related to soybean cake exported to the EU and fed to dairy cows account for ~ 16 million t CO2 eq/year (FAO, 2010)

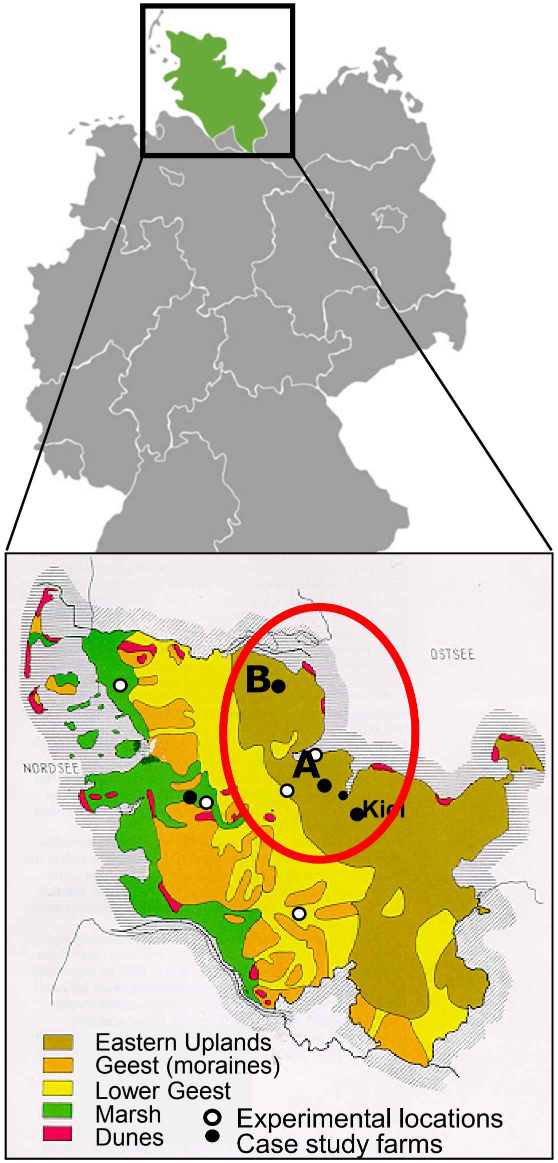
Increase of soybean area in Cerrado: 10 Mio. ha (1970 – 2000) Fearnside, 2001

What does that mean for European dairy systems? Learning from the Irish? Pasturing in Germany…

EU-Interreg-Project "Enhancing resource efficiency in dairy farming systems"

A. High Input

- Milk (kg/cow/yr): 11.000
- Indoor year-round
- Forage: silage (grass, maize)
- Concentrates: >3.000 kg/cow/yr
  - 32% soybean meal
  - 22% rapeseed meal
  - 20% grain
  - 14% molasses
  - 12% others
- Stocking rate: 2.1 LU/ha



B. Low Input

- Milk (kg/cow/yr): 6.000
- Pasturing >9 month
- Forage: grass-clover
- Concentrates: <250 kg/cow/yr
  - 70% maize
  - 30% lupines
- Stocking rate: 1.2 LU/ha

Taube et al., 2014
Grass and Forage Sci., 69, 2-16

Methods: LCA „cradle to farm-gate“

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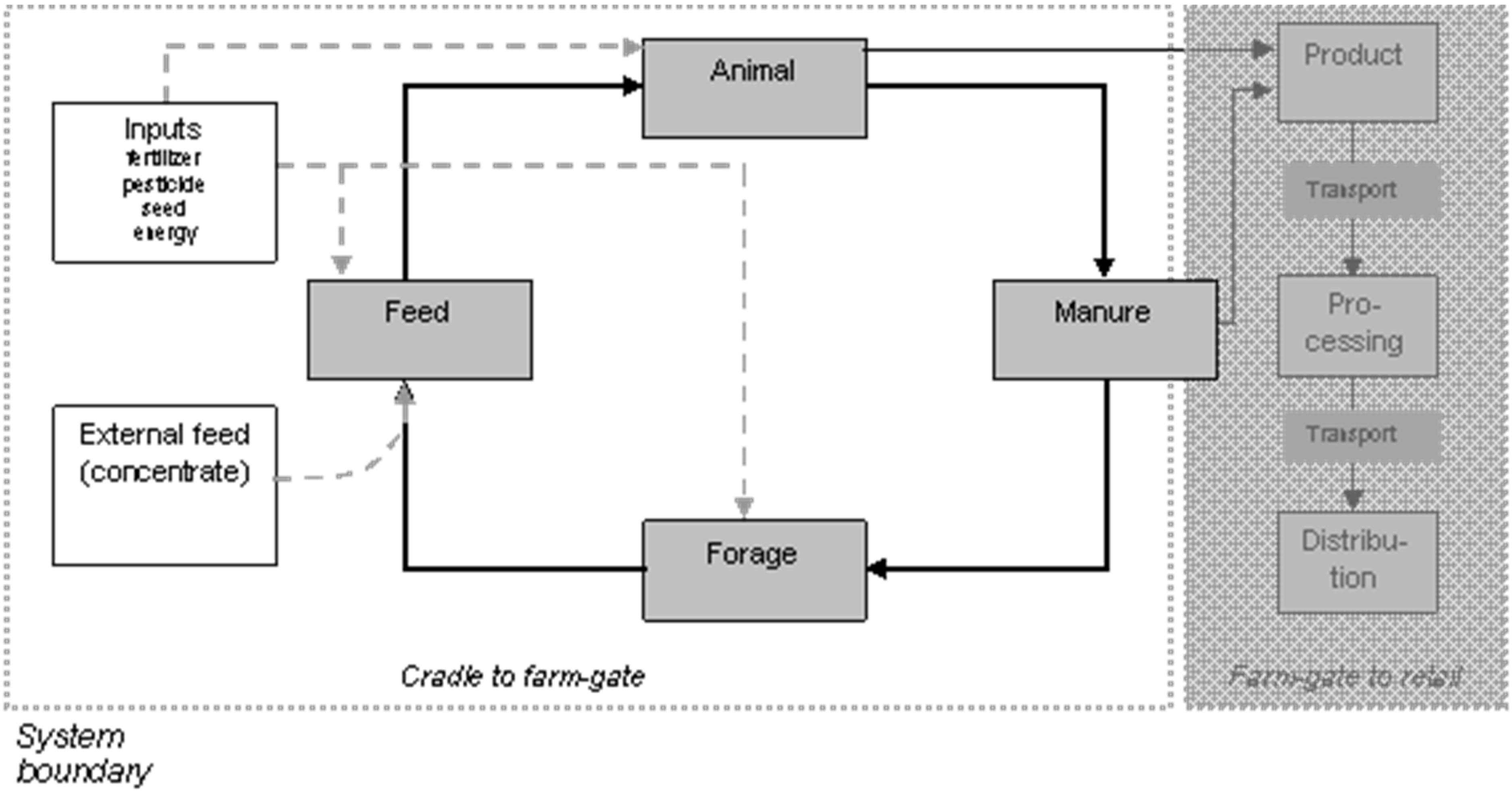

Off-farm

External farm inputs (production/transport)

- Feed import
- Fertilizer
- Energy
- Pesticides
- Seeds
- Land use change (LUC)

CO_2, CH_4, N_2O

On-farm

Forage production (field-level)

- Nitrate leaching
- Soil organic C
- Soil-atmosphere trace gas exchange (N_2O, CH_4)

CO_2, CH_4, N_2O

Animal husbandry (animals/manure)

- Enteric fermentation
- Manure storage

CH_4, N_2O

$\sum CO_{2equivalents}$

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Global warming potential (IPCC, 2006): CO2=1, CH4=25, N2O=298

Methods: LCA „cradle to farm-gate“

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	Sources	Greenhouse gas	Emission factors from:
On-farm (animal/manure)	Enteric ferment.	CH_4	IPCC 2006 Tier 2
	Manure/slurry	CH_4	IPCC 2006 Tier 2
	Manure/slurry	N_2O direct	IPCC 2006 Tier 2
	Ammonia slurry	N_2O indirect	IPCC 2006 Tier 2
On-farm (forage prod./ pasture)	**Leaching nitrate**	**N_2O indirect**	**(Measured)**
	Field-level	**N_2O direct**	**Measured**
	Field-level	**CH_4**	**Measured**
	Field-level C sequestration	CO_2	Körschens 2005
Off-farm (external inputs)	Fertilizer (N, P, K)	CO_2, CH_4, N_2O	Patyk & Reinhardt 1997
	Energy	CO_2, CH_4, N_2O	Patyk & Reinhardt 1997
	Ext. feedstuff	CO_2, CH_4, N_2O	Eriksson et al. 2005
	Land use change (off-farm)	CO_2, CH_4, N_2O	FAO 2010
	Pesticides	CO_2, CH_4, N_2O	Biskupek 1997
	Seeds	CO_2, CH_4, N_2O	Ecoinvent 2009

INTERREG 4A SYDDANMARK-SCHLESWIG-K.E.R.N.

Eco-efficiency - Product Carbon footprint milk
"High input" confinement versus "low input" pasture system

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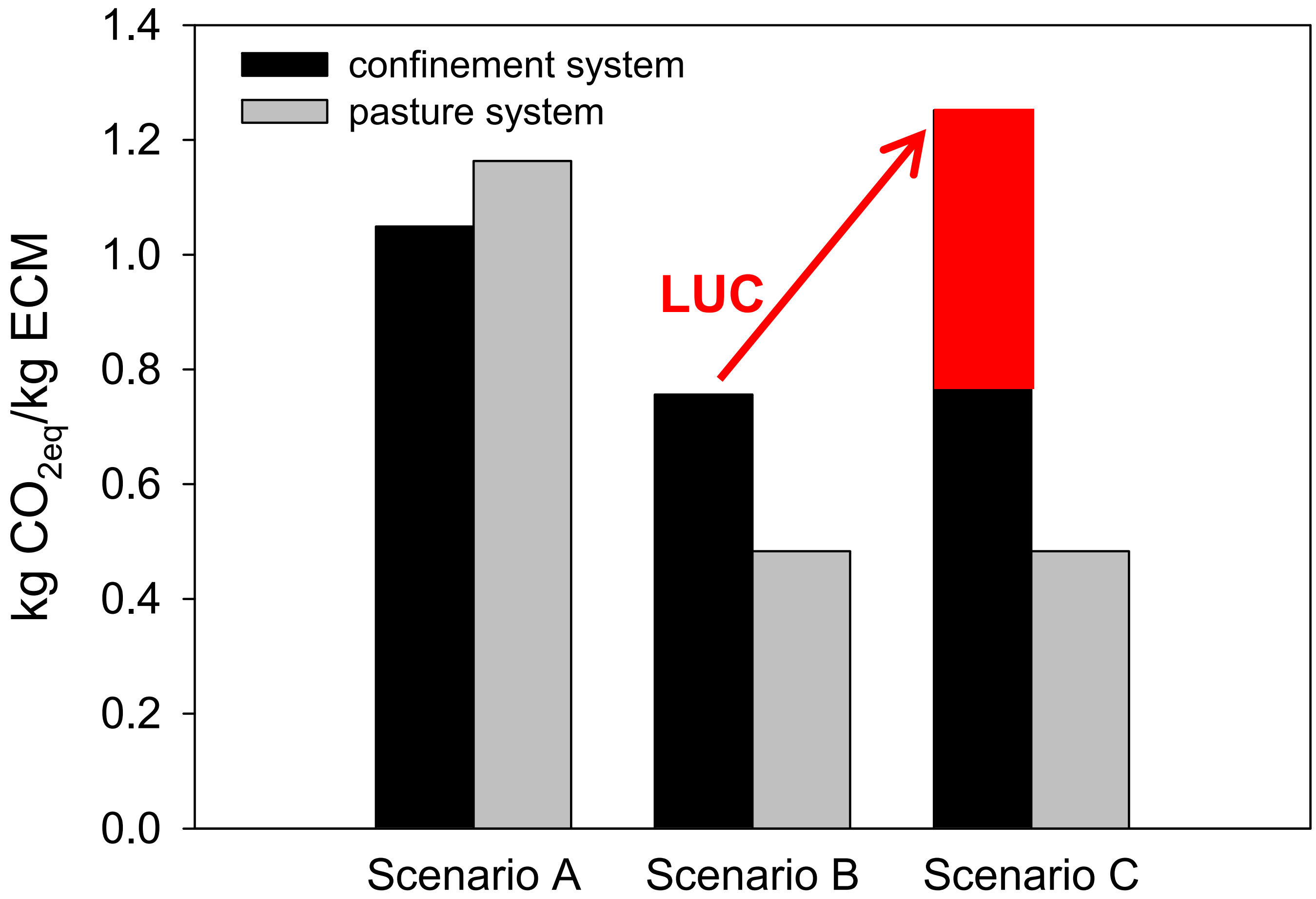
Results: EU-Interreg-Project "Enhancing resource efficiency in dairy farming systems"



	Scenario A	Scenario B	Scenario C
C sequestration forage area:	–	☑	☑
Land use change (LUC):	–	–	☑

Taube et al., 2014

Eco-efficiency - Product Carbon Footprint (PCF) milk
“High input” confinement versus “low input” pasture system

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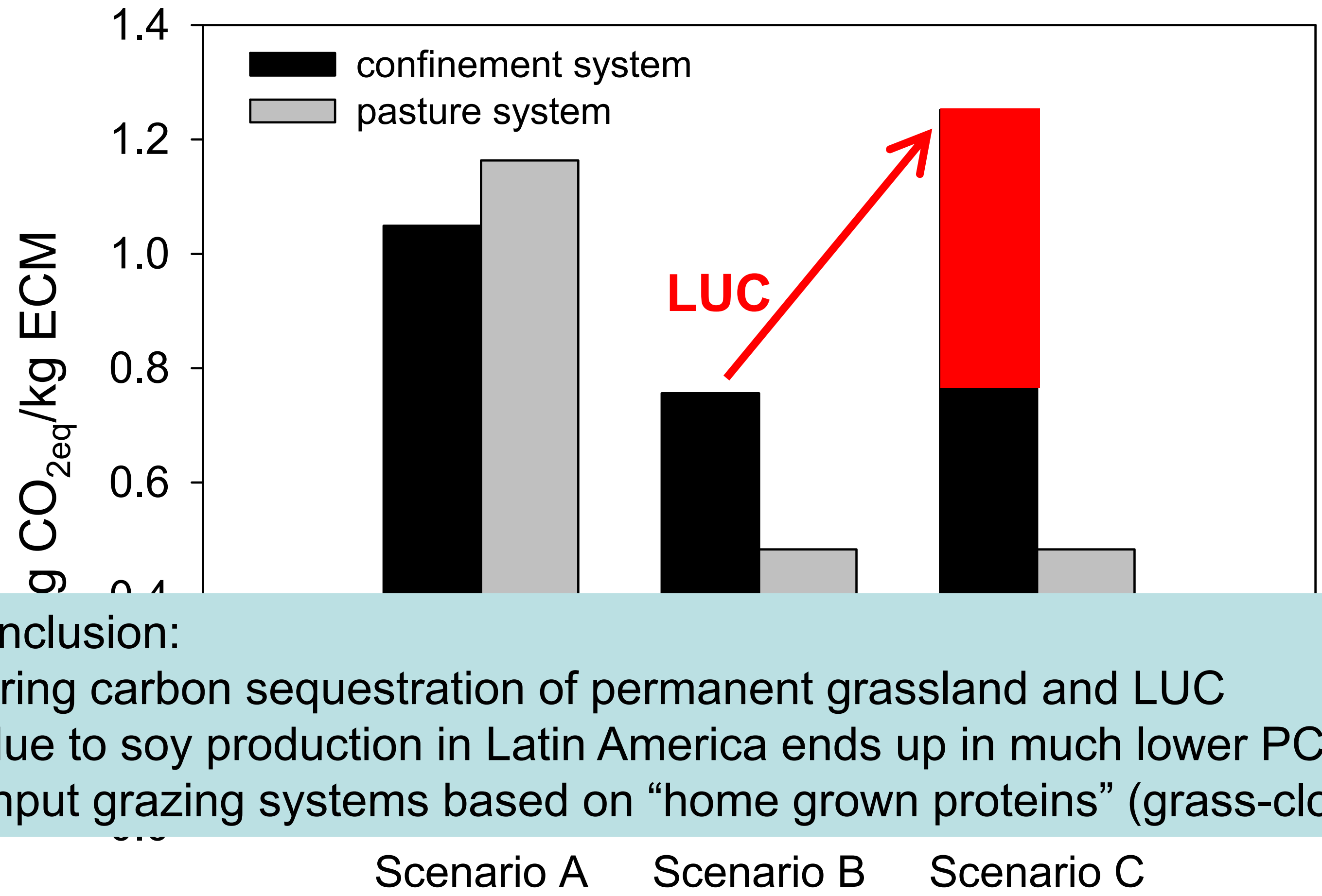
Results: EU-Interreg-Project “Enhancing resource efficiency in dairy farming systems”

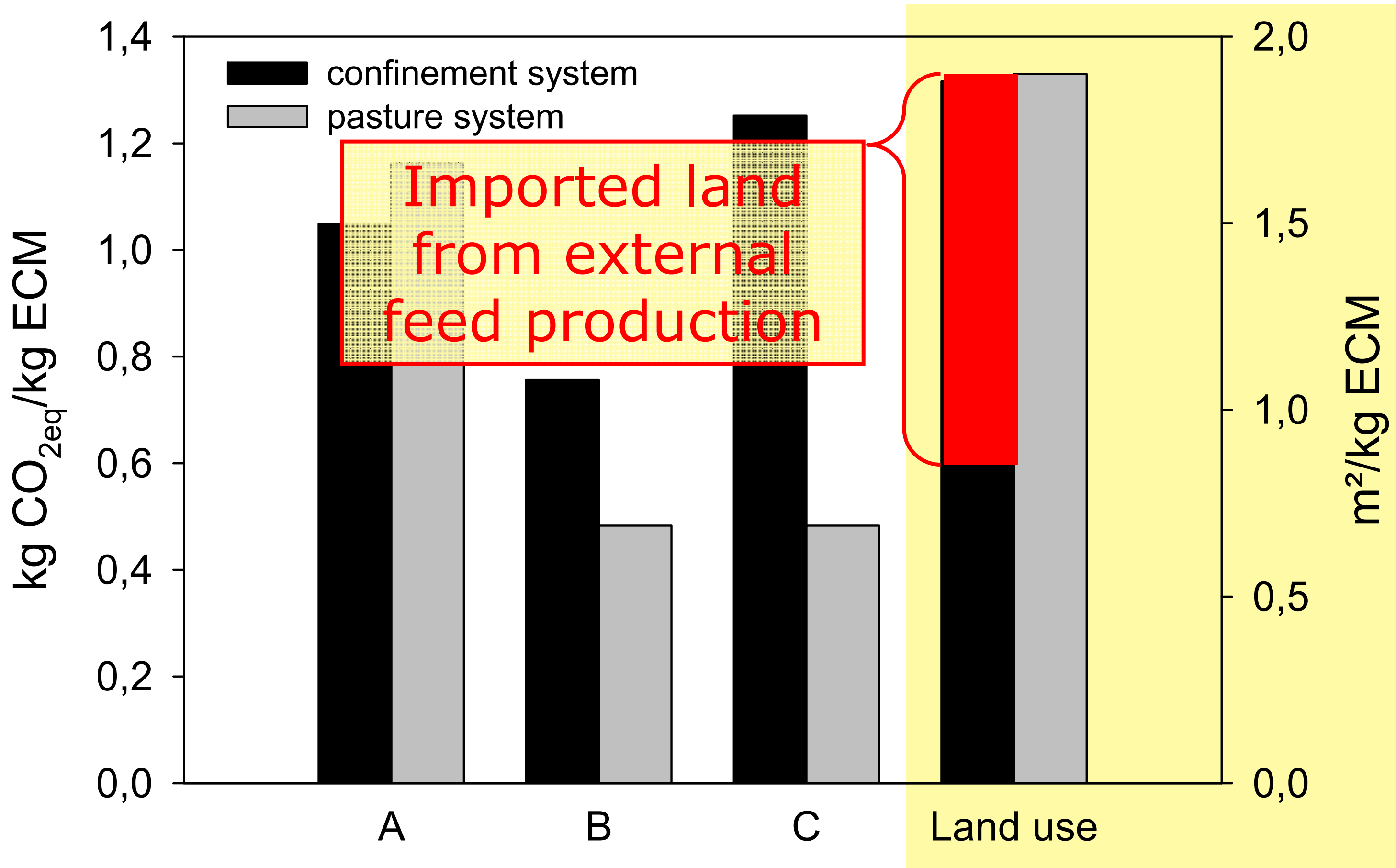


Third conclusion:
Considering carbon sequestration of permanent grassland and LUC effects due to soy production in Latin America ends up in much lower PCF’s for low input grazing systems based on “home grown proteins” (grass-clover)

	Scenario A	Scenario B	Scenario C
C sequestration forage area:	–	☑	☑
Land use change (LUC):	–	–	☑

Taube et al., 2014

"Global land area demand" per kg ECM produced…



C sequestration forage area: — ☑ ☑

Land use change (LUC): — — ☑

Taube et al., 2014

“Global land area demand” per kg ECM produced…

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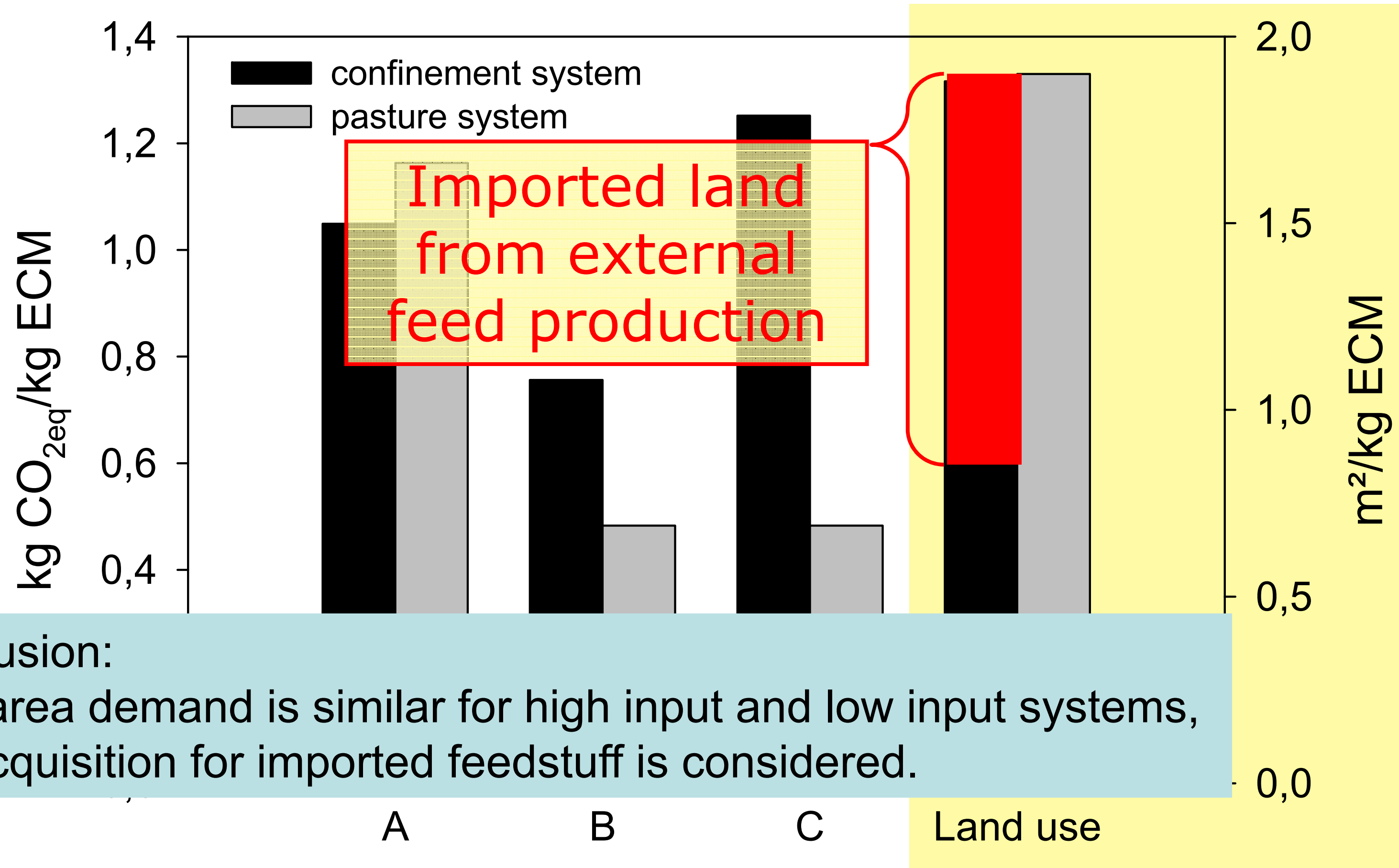

Fourth conclusion:
Global land area demand is similar for high input and low input systems, when land acquisition for imported feedstuff is considered.

	A	B	C
C sequestration forage area:	–	☑	☑
Land use change (LUC):	–	–	☑

Taube et al., 2014

Final conclusions

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- SI concepts for European dairy systems have to be developed in a global context
- Eco-efficiency analysis is a promising scientific tool to derive pathways towards SI locally adopted in different regions of Europe > research needed > allocation methods etc.!
- The challenge is to create win-win solutions, e.g. pasture systems for dairy cows: low PCF, low N surplus, high animal welfare, positive effects on biodiversity, resilience of soils, reduced workload for the farmer (social dimension of SI), aesthetics of agricultural landscapes, …
- Thus, grassland based production systems are a pre-requisite in terms of the ecological dimension of sustainability - in Europe and Latin America!

Thank you very much for your attention…

CAU
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…and to my co-workers:
Antje Herrmann, Ralf Loges, Martin Gierus, Philipp Schönbach, Thorsten Biegemann, Arne Poyda, Nico Svoboda, Maria Schmeer und many others…

Grazing experiment „home grown proteins – forage legumes“ – reseach farm Lindhof

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