NJF seminar 405: Production and Utilization of Crops for Energy. 25-26 September 2007, Vilnius, Lithuania

Why diversify biomass production for biofuels

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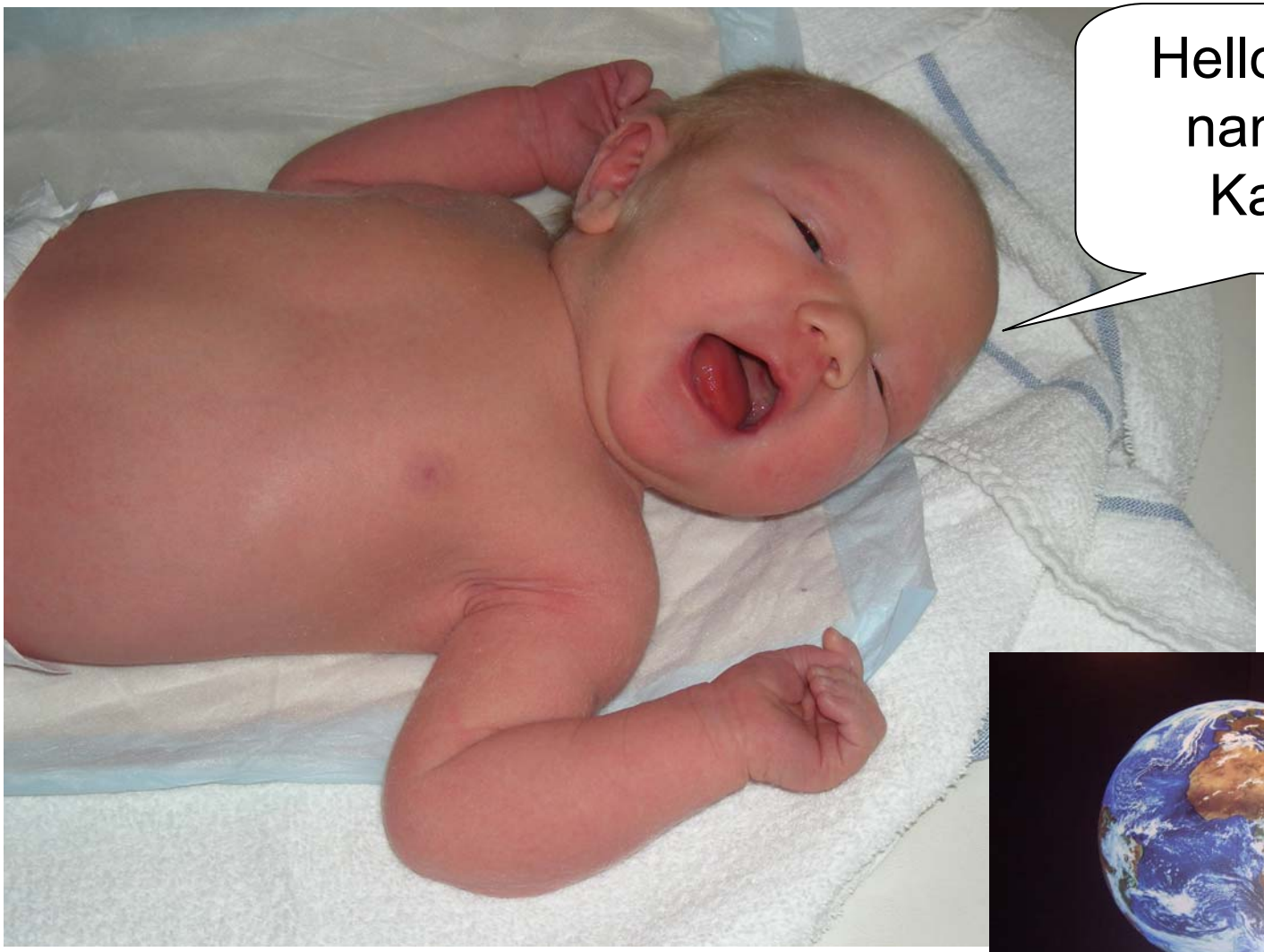
A new EU citizen was born in DK 28. Aug 07



Agenda for the next 25 minutes

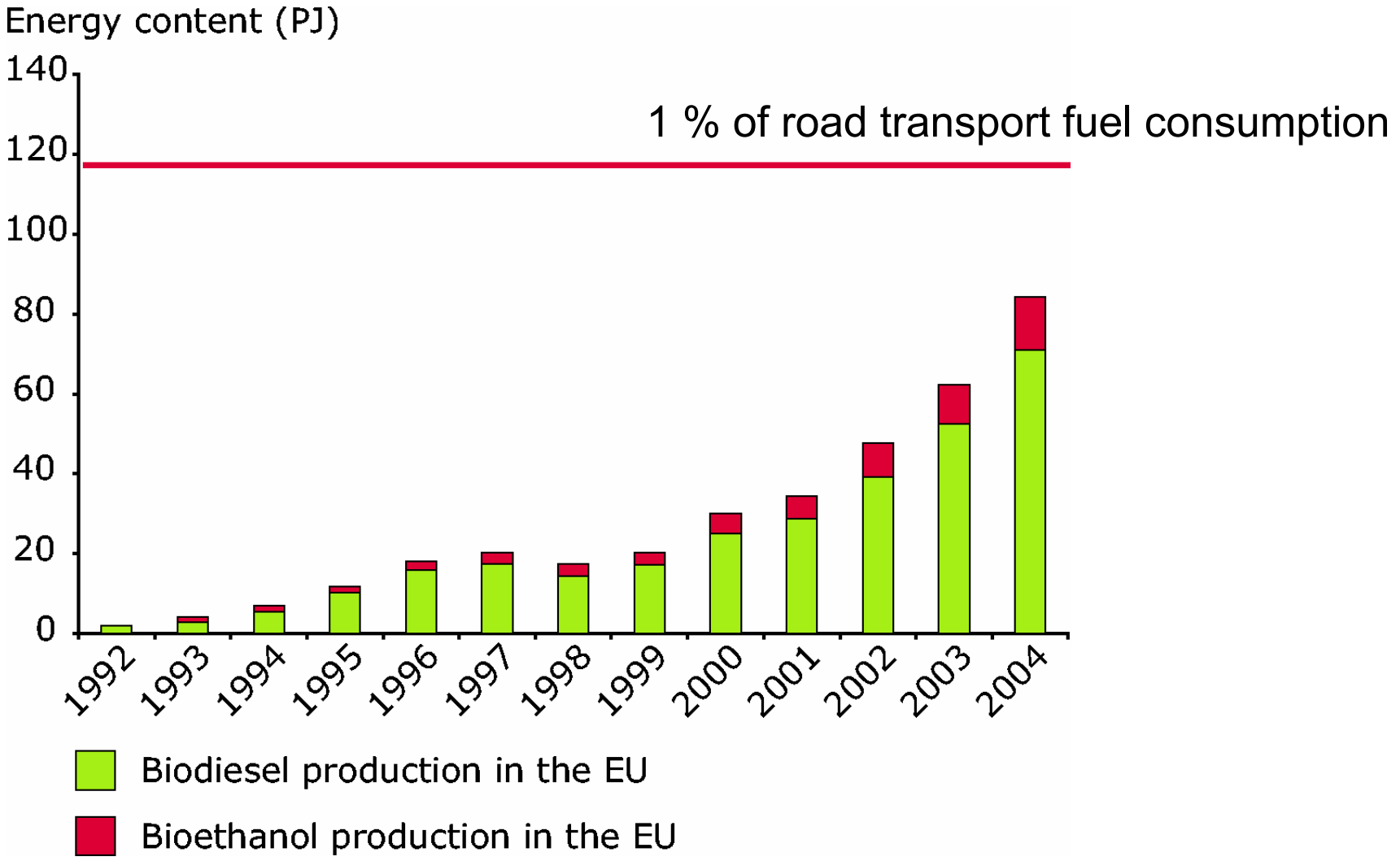
- Biofuels and EU
- GHG balances and the Danish IBUS concept
- Diversifying biomass production
  - exemplified by results produced from 3 yr field experimentations in 5 different EU countries using pea-barley intercropping
- Conclusion

The situation about biofuels

- Accoding to EU agreement the amount of biofuels will be increased to at least 5.75% of the total consumption of fuel for transportation by 2010 and at least 10% by 2020

- Objectives are CO_2-reduction and sustainability

Biofuels in Europe



Source: EEA, 2006, Fact sheet 31

Biomass is a renewable energy resource

Plant production:

$CO_2 + H_2O + \text{sunlight} \quad \text{(chlorophyll)} \Rightarrow (CH_2O)_n + O_2$

Combustion of plants (or plant derived products):

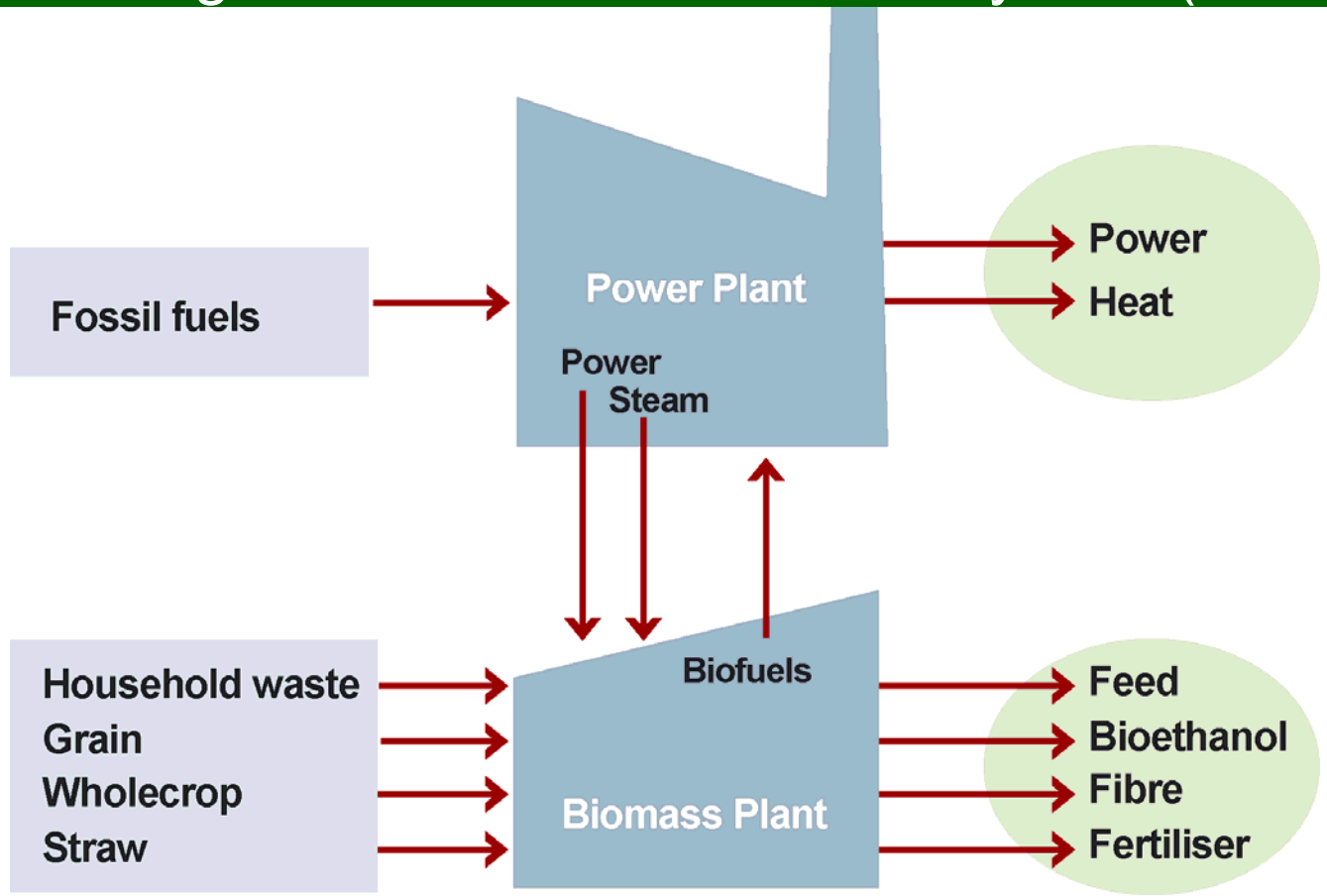
$(CH_2O)_n + O_2 \Rightarrow \text{Energy} + H_2O + CO_2$

- Plants contain stored solar energy
- Plants capture and reduce CO_2
- Plants contain nutrient element for fermentation, including production of organic fertilizer

Sustainability and fossil consuming elements

- Diesel
- N fertilizer
- P,K,S fertilizer
- Herbicides
- Fungicides
- Insecticides
- Growth regulators
- Irrigation

The Danish Integrated Biomass Utilization System (IBUS)



Partners:

Copenhagen University Life

Sicco K/S (DK – engineering company)

TMO biotec (UK – termophilic microorganisms)

Risø National Laboratory, Technical University Denmark

Up-scaling pilot studies to commercial factory

100 kg straw h^{-1} (2004)

1000 kg straw h^{-1} (2006)

2G bioethanol production using straw as raw material

Lignocellulose raw material

Xylanase

Microorganism?

C5

250 kg EtOH per tons straw

Pretreatment

Hemicellulose

Cellulose

Lignin

Cellulases

Yeast

C6

Hydrolyses

Fermentation

Distillation

GHG balances using the IBUS concept

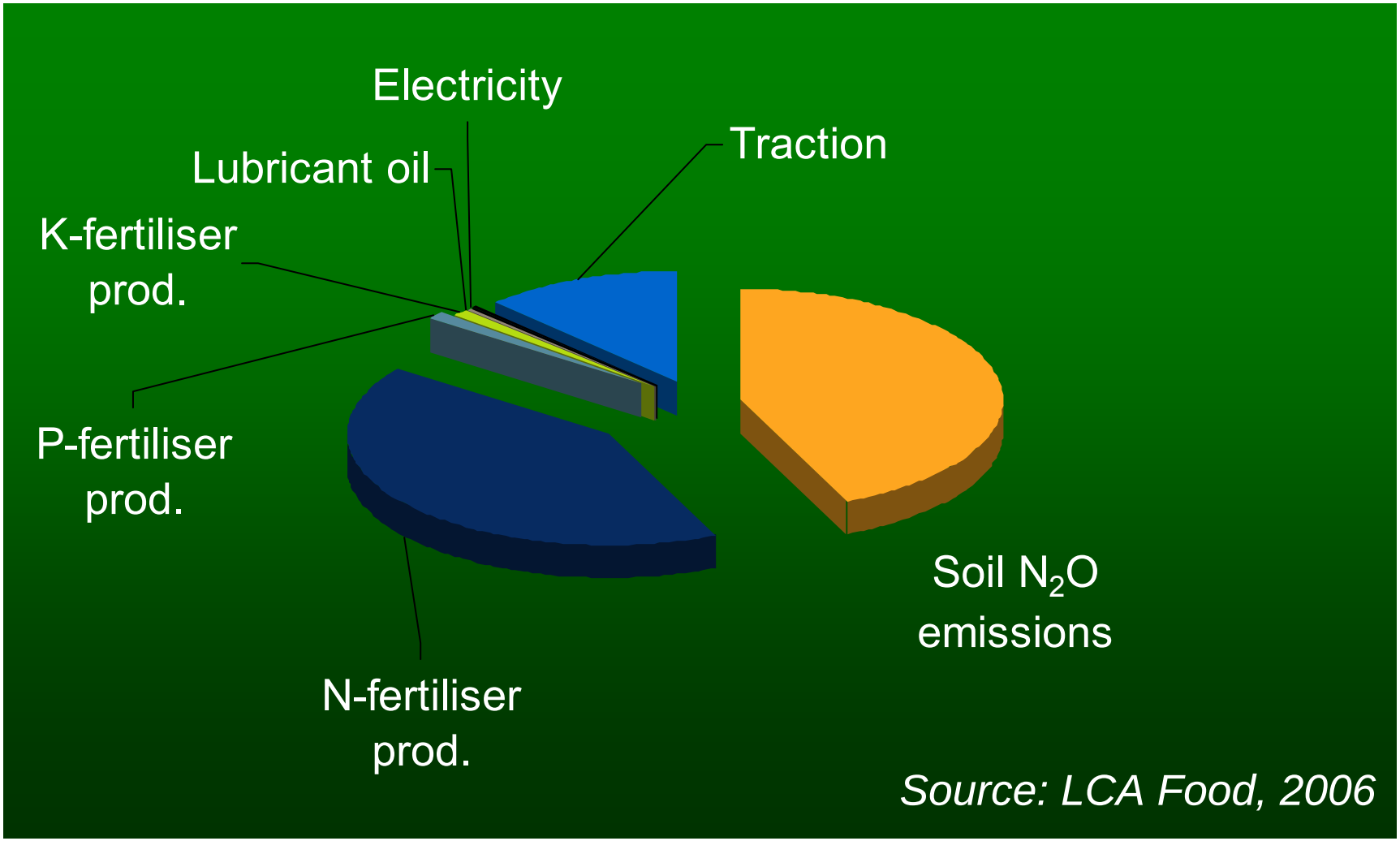
Conclusions based upon LCA perspectives incl. entire production chain

- Grain (wheat) based ethanol results in modest or even negative GHG emissions compared to neat petrol reference case
- Straw (wheat) based ethanol show a great potential for GHG savings

- Biomass production and management is a very prominent source of GHG emissions in these calculations
  - Looking at the entire ethanol production cycle it can be concluded
    1. generation ethanol - 60-70% of total emissions
    2. generation ethanol - 30-45% of total emissions

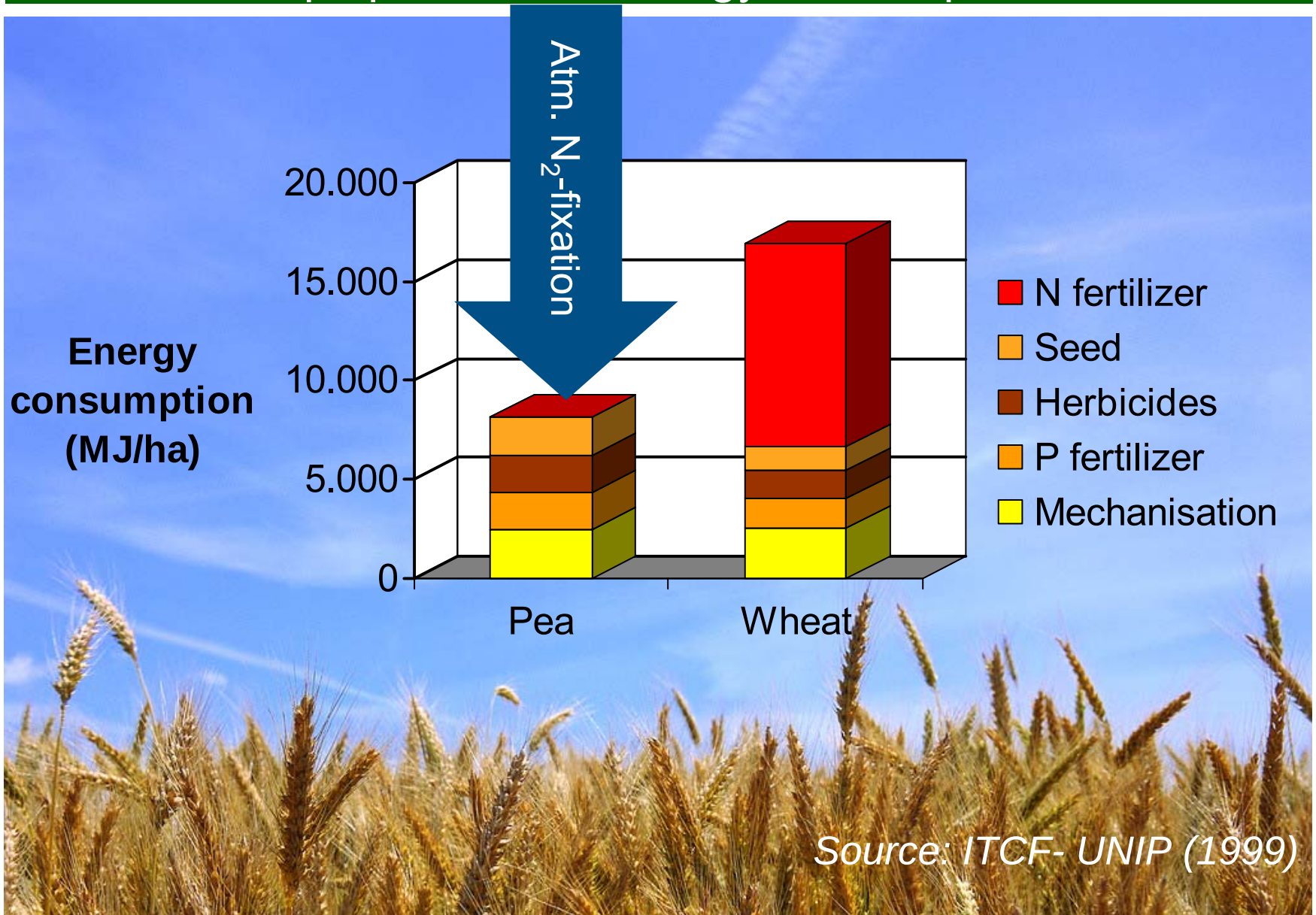
Source: van Maarschalkerweerd, 2006

GHG emission sources from Danish wheat grain production



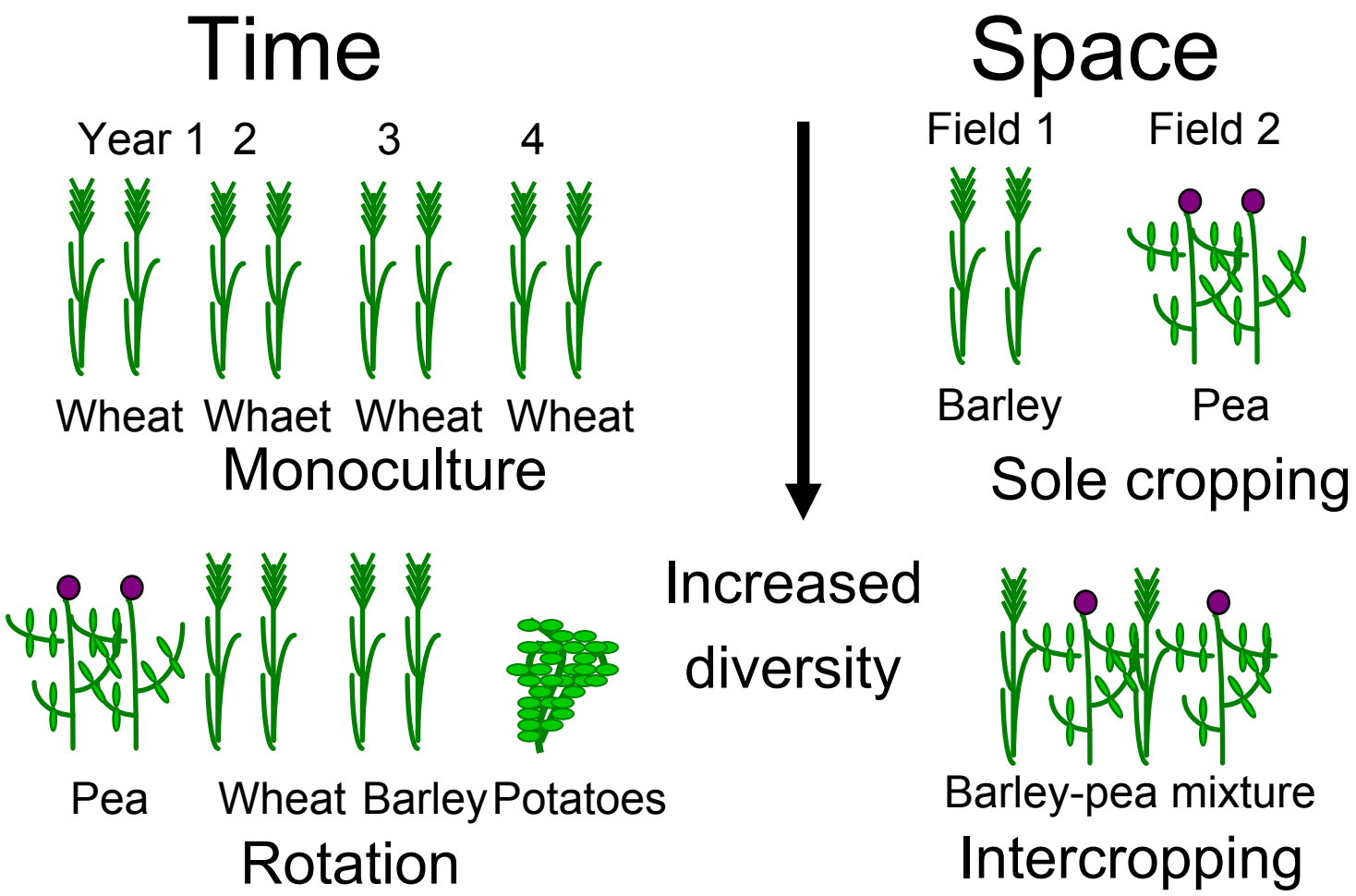
Source: LCA Food, 2006

Choice of crop species and energy consumption



Source: ITCF- UNIP (1999)

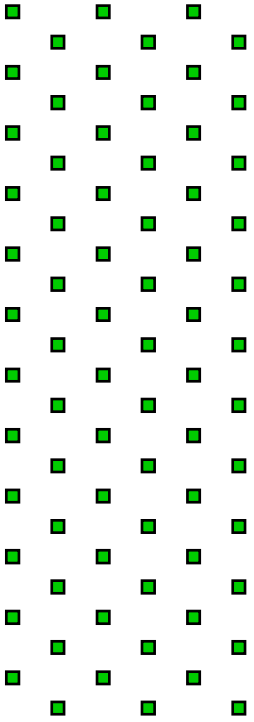
Diversifying biomass production?



Basic pea(■)-barley(■) intercrop design – 3 yrs

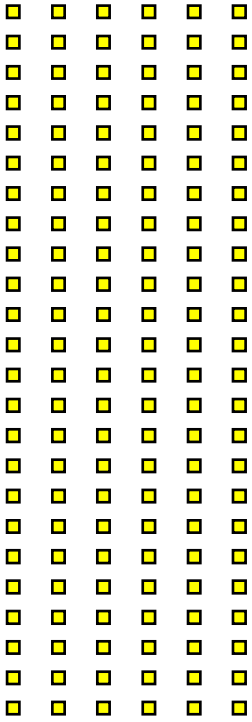
Sole cropping

P100



90 pl. m^{-2}

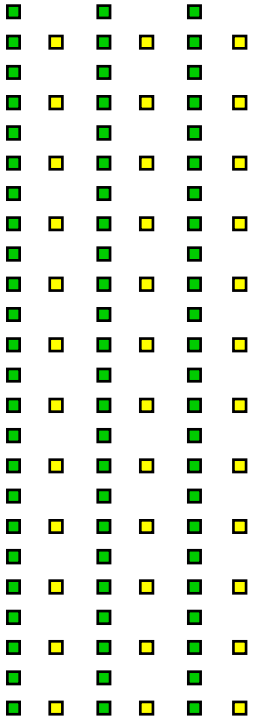
B100



300 pl. m^{-2}

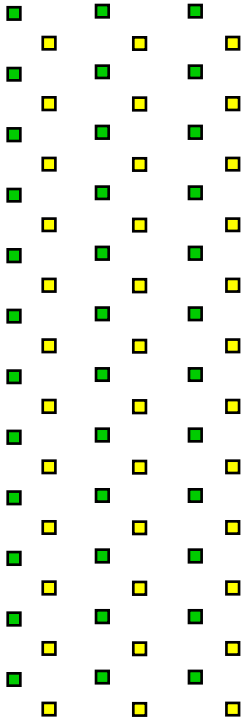
Row-by-row intercropping

P100B50



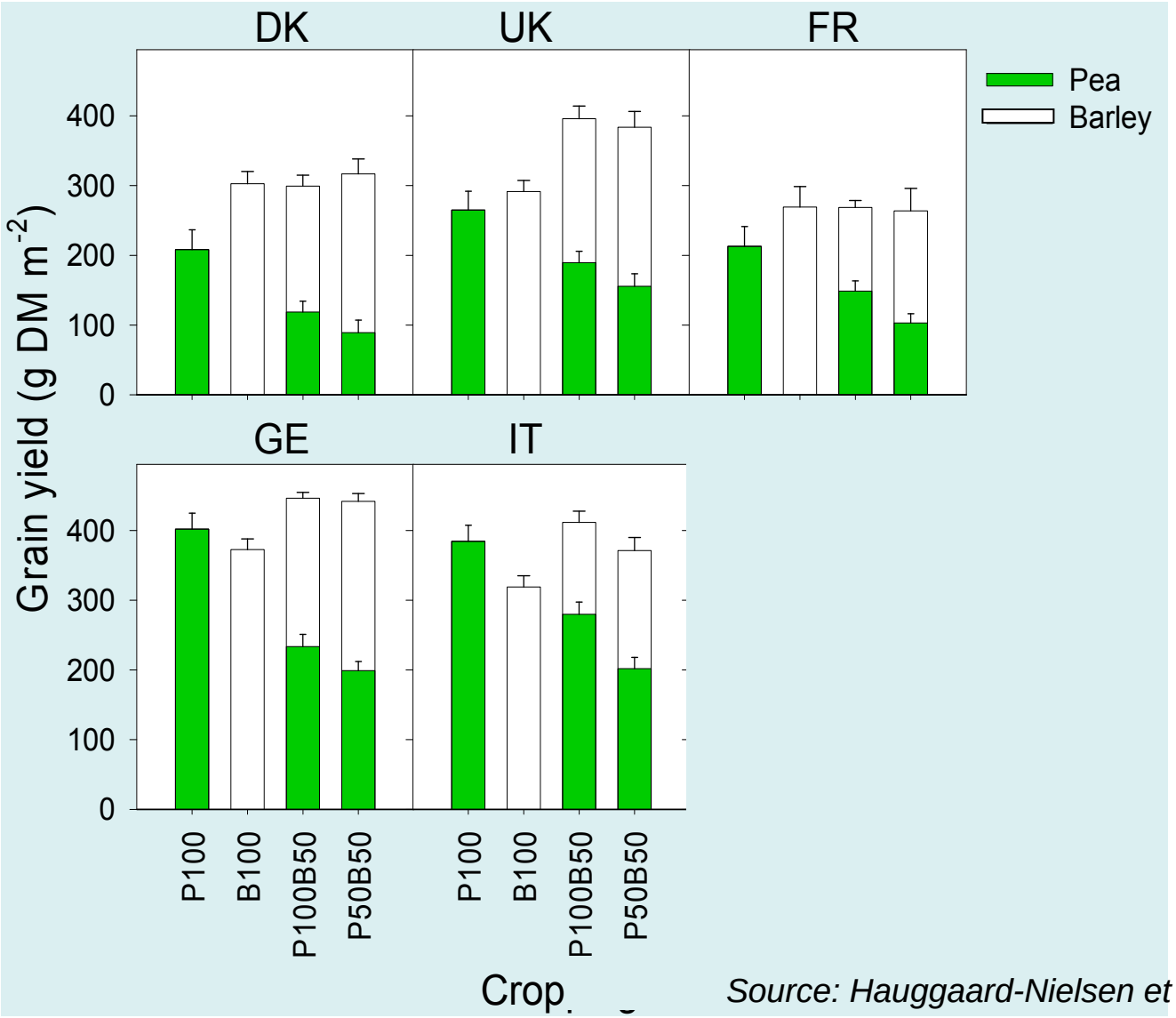
90+150 pl. m^{-2}

P50B50



45+150 pl. m^{-2}

Pea-barley intercrop agronomic performance



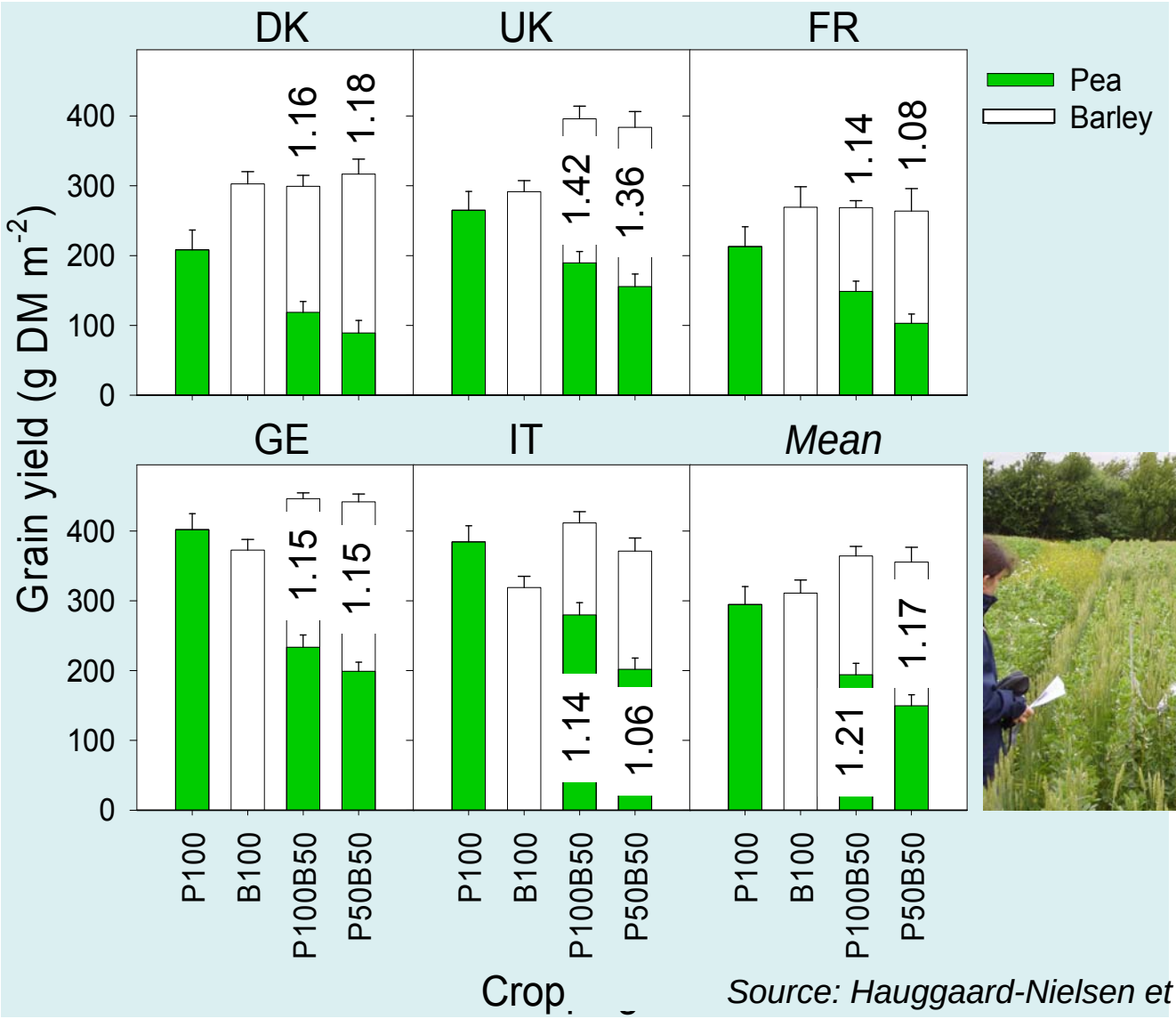
Source: Hauggaard-Nielsen et al., in prep.

Land Equivalent Ratio (LER)

$$LER_{AB} = \frac{Y_{AB}}{Y_{AA}} + \frac{Y_{BA}}{Y_{BB}}$$

LER > 1: Advantage from intercropping
LER < 1: Advantage from sole cropping

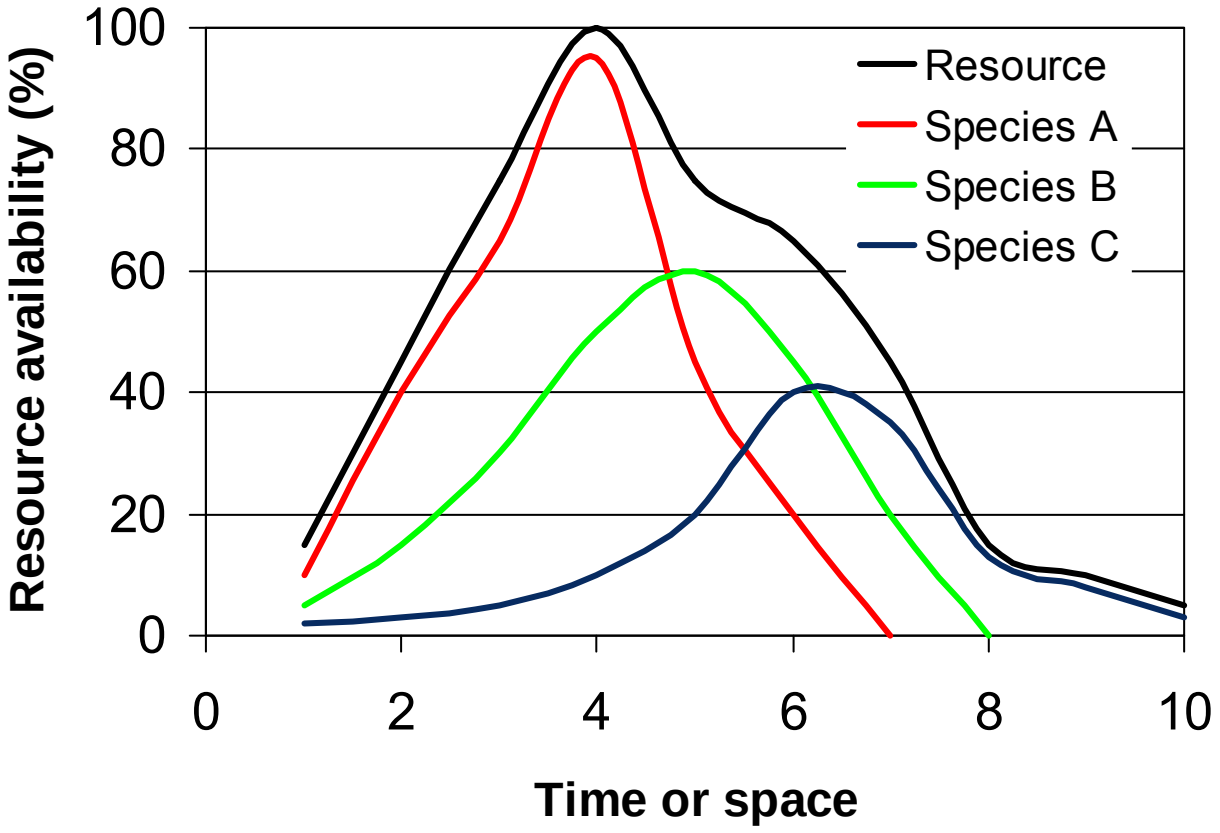
Pea-barley intercrop agronomic performance - LER



Source: Hauggaard-Nielsen et al., in prep.

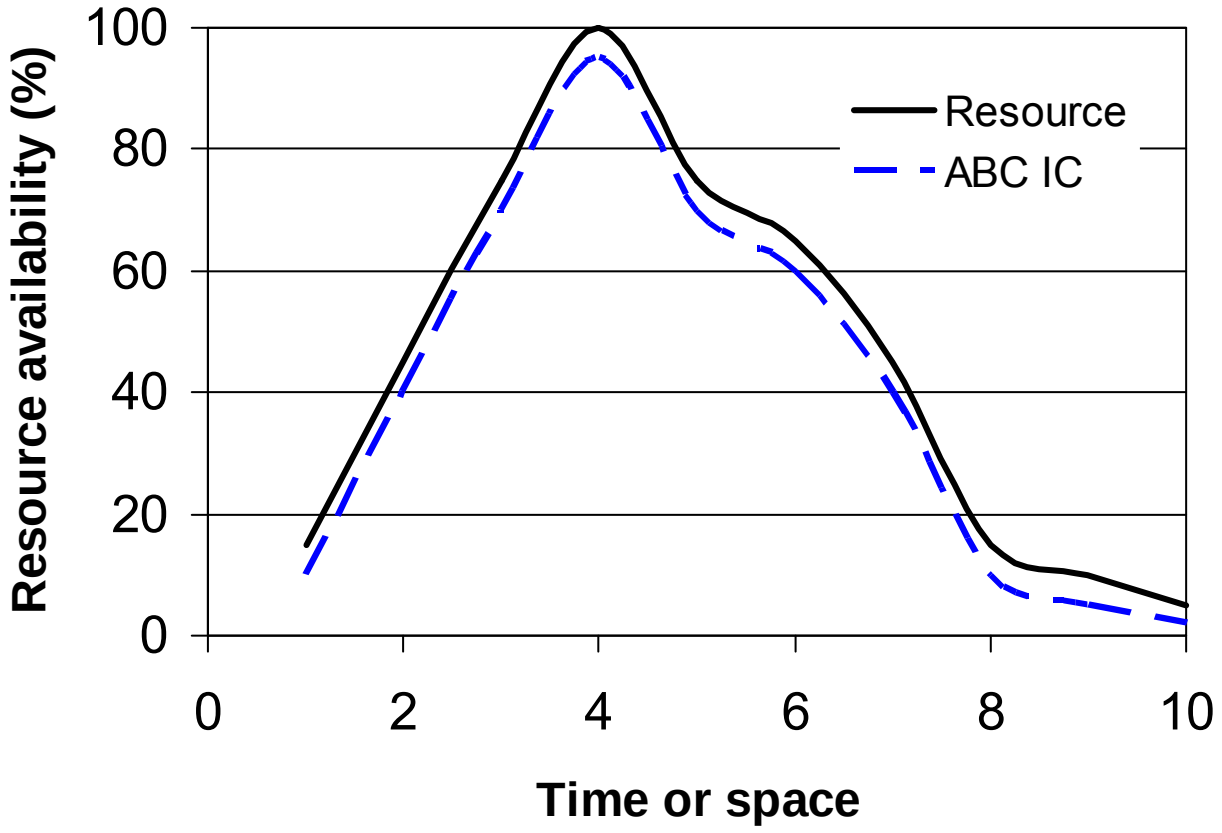
Complementary use of resources

- Complementarity is implemented in the crop stand when species utilize resources differently



Species complementarity and resource use

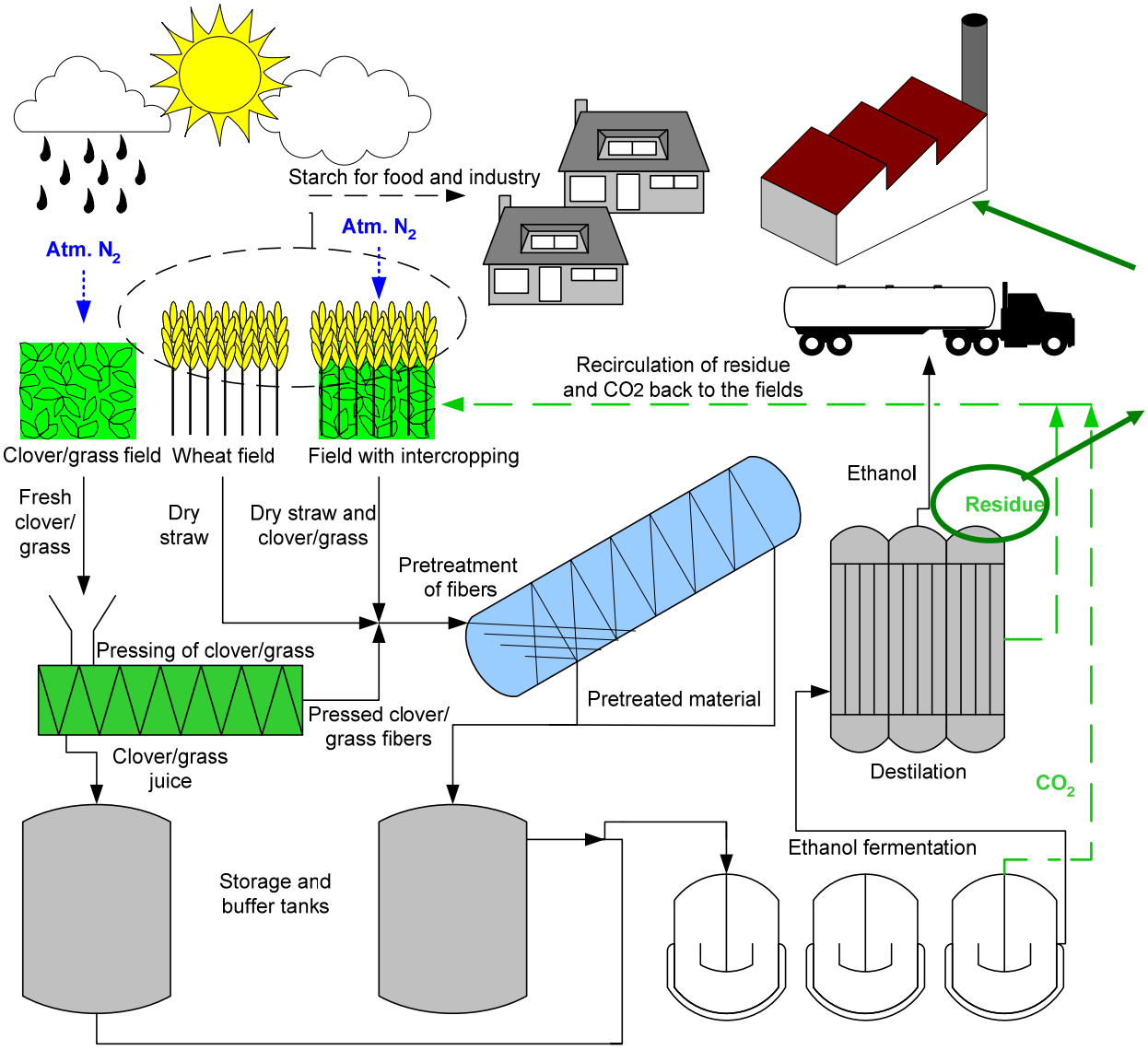
- When improving the knowledge level about interspecific competition a higher degree of local resource use efficiency can be obtained



Fossil consuming elements and intercropping

• Diesel	(+)
• N fertilizer	+
• P,K,S fertilizer	(+)
• Herbicides	+
• Fungicides	(+)
• Insecticides	(+)
• Growth regulators	+
• Irrigation	….

Centralized and/or decentralized biorefinery concept



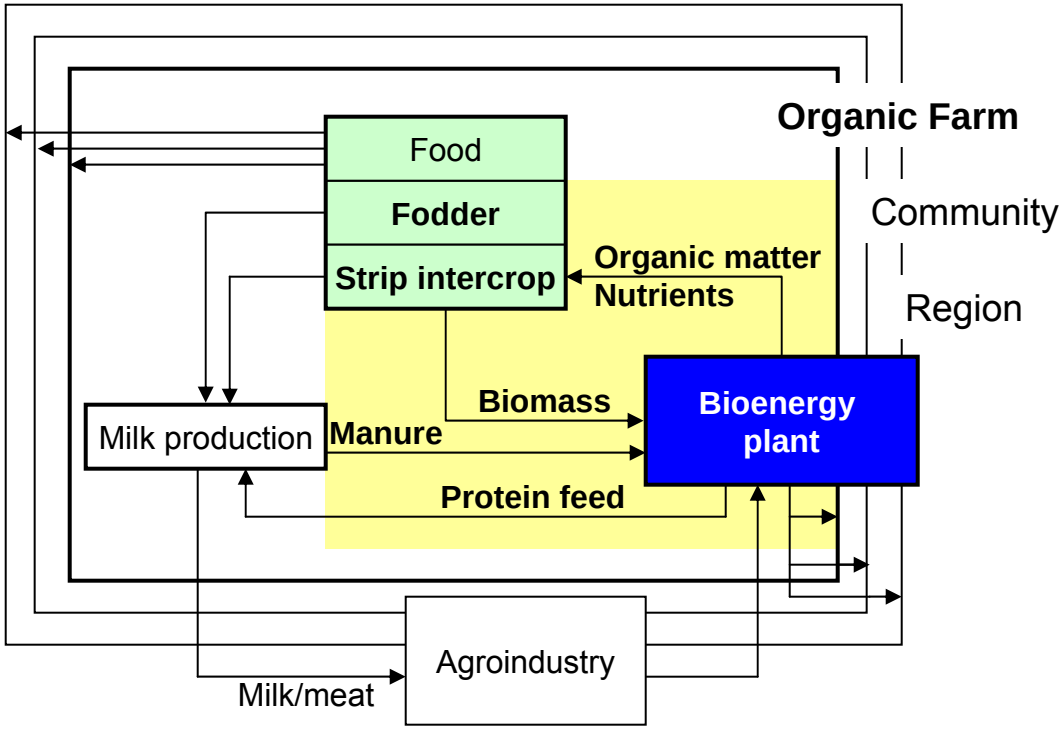
High value protein rich feed product

Fertiliser rich in micro and macro nutrients

Biomass and bioenergy production in organic agriculture – consequences for soil fertility, environment, spread of animal parasites and socio-economy (Acr.: BioConcens).

- BioConcens aims at analyzing and suggesting solutions to the apparent opposing aims of bioenergy production and safeguarding soil fertility in OA.

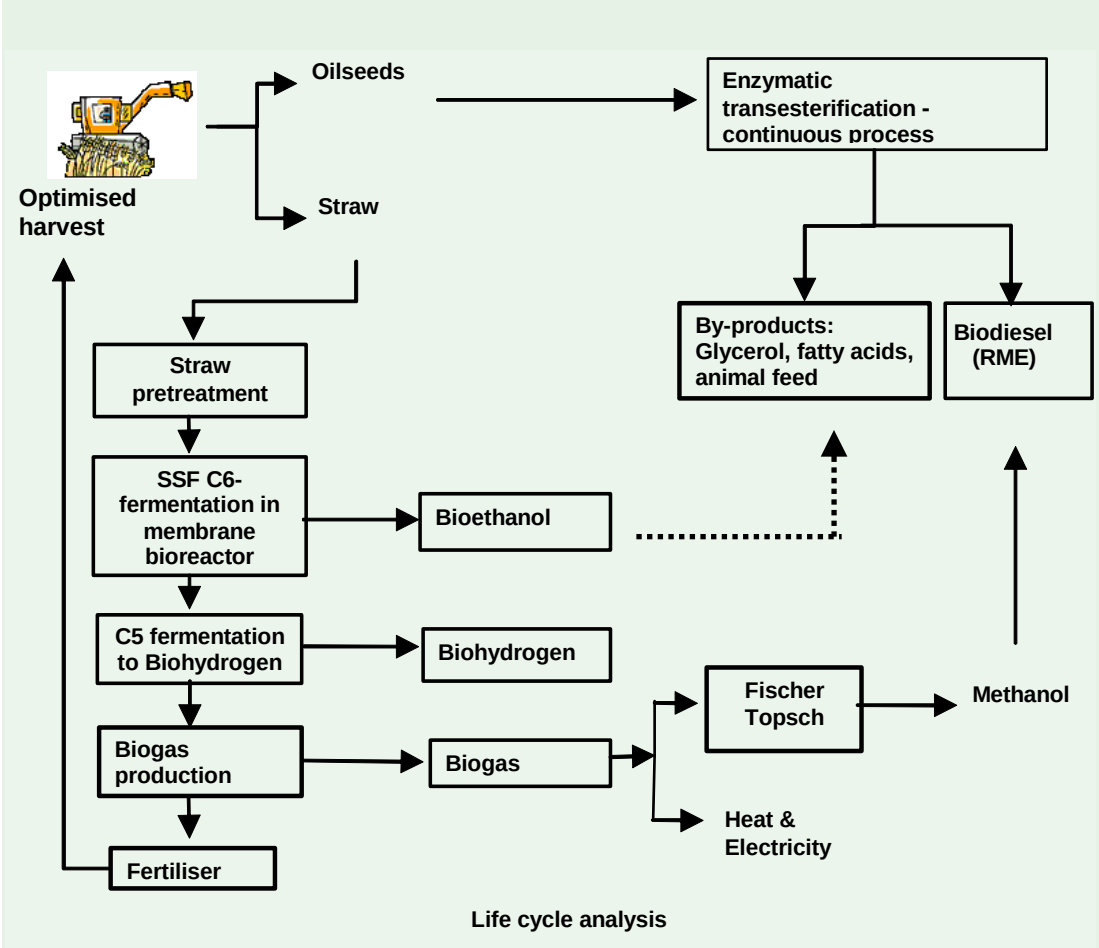
BioConcens concept framework (FØJOIII 2007-2011)



Biorefinery for sustainable Reliable Economical Fuel production from energy crops. Acronym: Bio.REF

AIM: Sustainable production of biofuels using residues for integrated multi-product production such as bio-diesel, -ethanol, -hydrogen, -gas as well as -pesticides.

(Bio.REF 2007-2010)



Conclusions

- Biomass is a key diversification strategy to improve energy supply security and mitigate GHG emissions
- Biomass production should be cultivated using the lowest possible input of fossil energy
- All sugars in the chosen biomass raw materials can be utilized by using the right biorefinery concept
- Ecosystem services should be validated together with their biofuel production potential

- Bioenergy systems are relatively complex, intersect
  sitespecific.
  - Solving prob
    ribution from agriculture,
    y and environmental sectors

Are we able to create such interdisciplinary collaborations?

Thanks for your attention

Remember to see and comment on the poster titled: *Sustainable biofuel production and validation of crop species – A qualitative approach*

by Steffen Bertelsen Blume and Henrik Hauggaard-Nielsen