

Green biorefinery as the tool to develop Northwestern European agriculture

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Northwestern European agriculture is challenged

Productivity & competitiveness

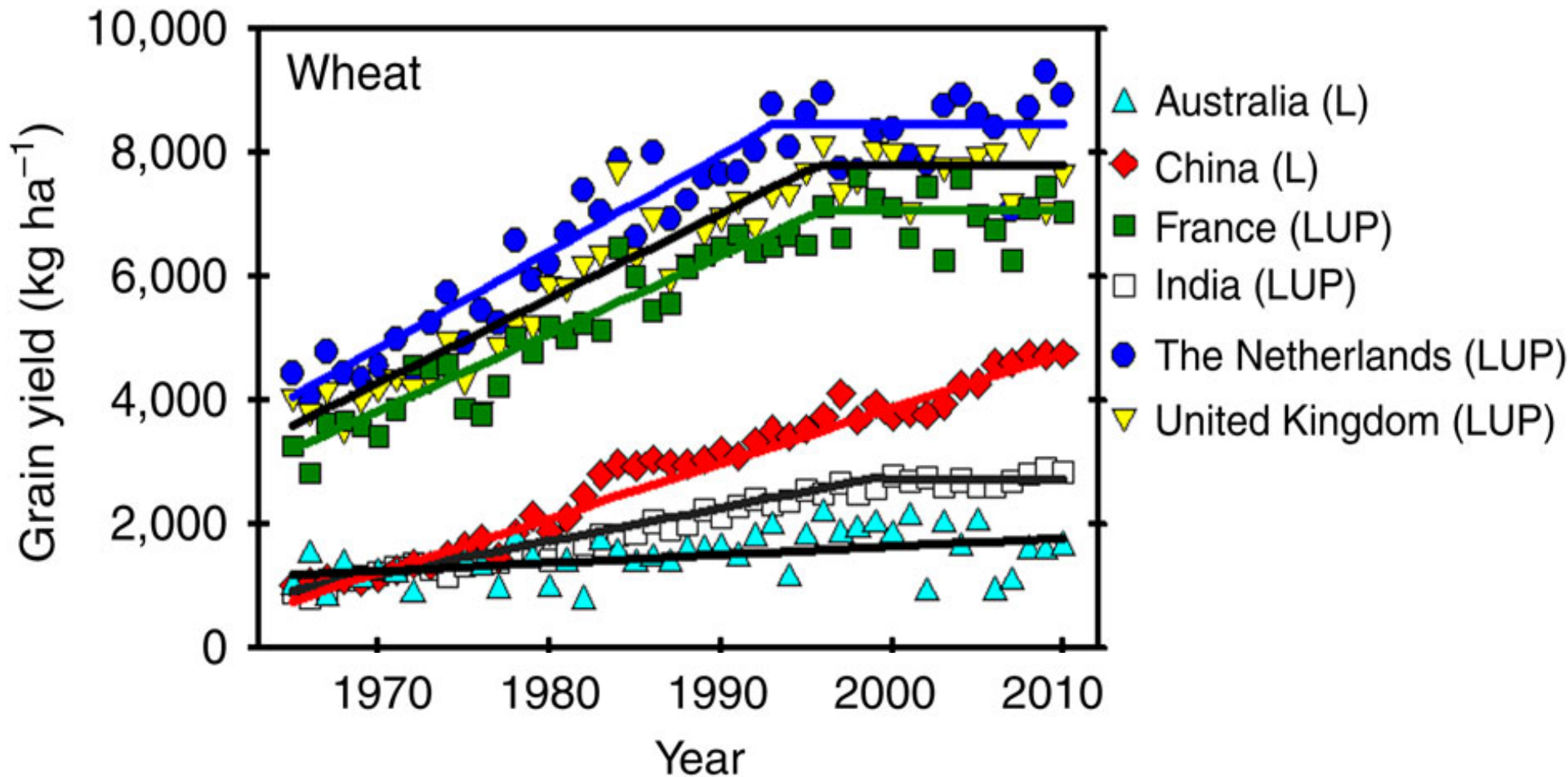
- Biomass for food, feed, material and energy
- Stagnating yields
- Large import of protein feed

Environment

- High nutrient leaching (EU Nitrate and Water Framework Directives)
- High pesticide use
- Soil and wind erosion
- Agriculture must contribute to EU climate goals (EU climate policy)

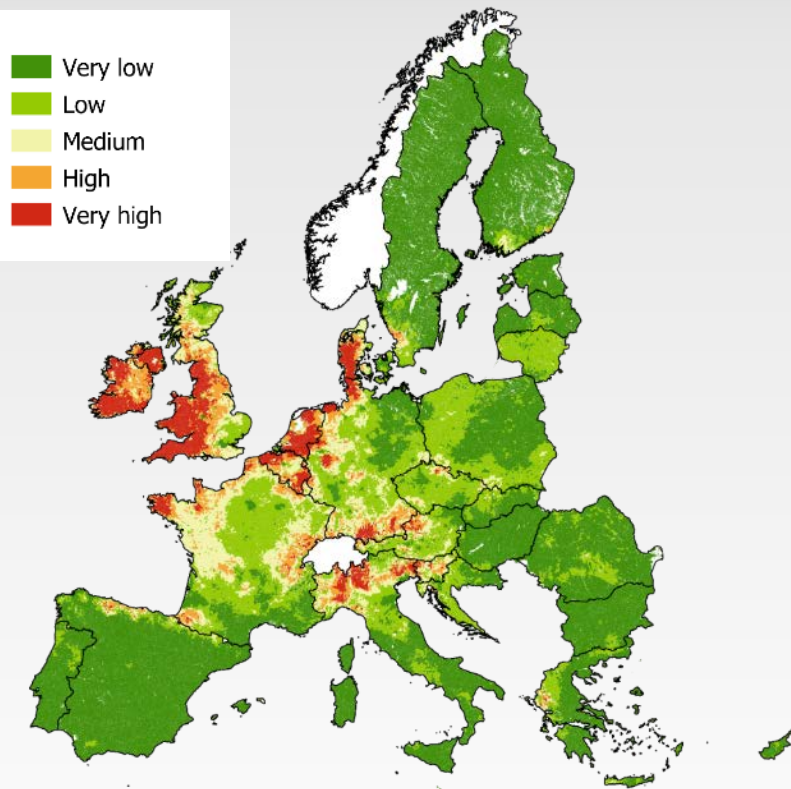
Time to look for radical innovation instead of just incremental

It seems hard to increase yields (sustainably) in existing crops in Europe

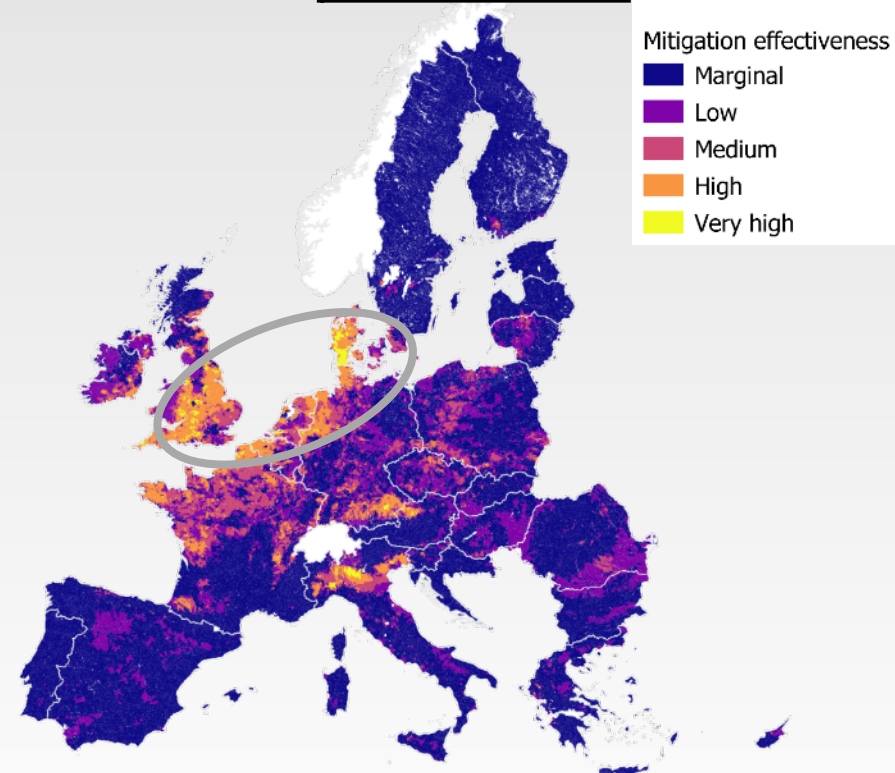


There are strong drivers for change -
e.g. N emissions to water from agricultural land
(Englund et al., 2019)

Degree of current impact

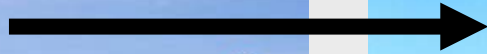


Effectiveness of strategic
perennialization



Strategic perennialization

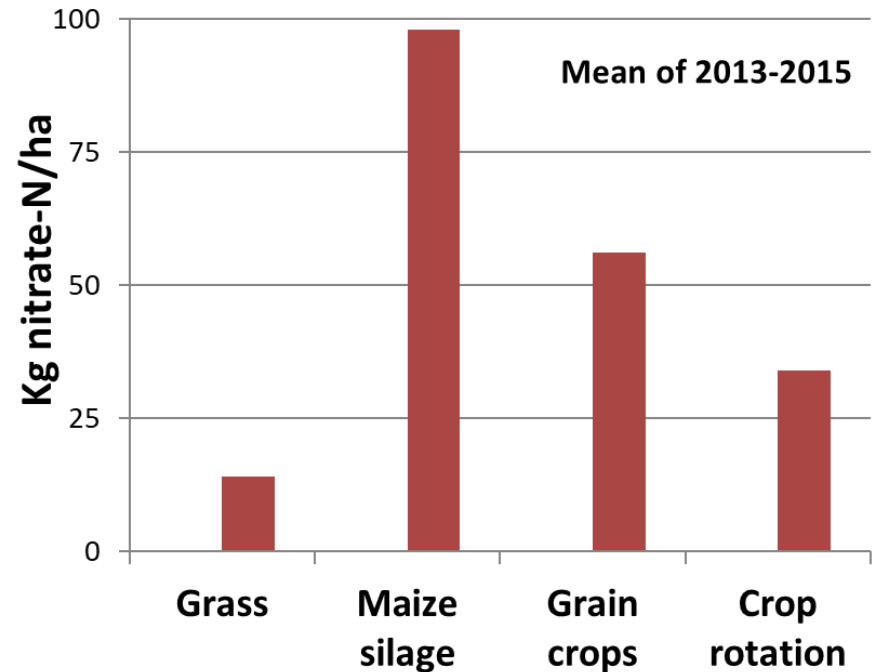
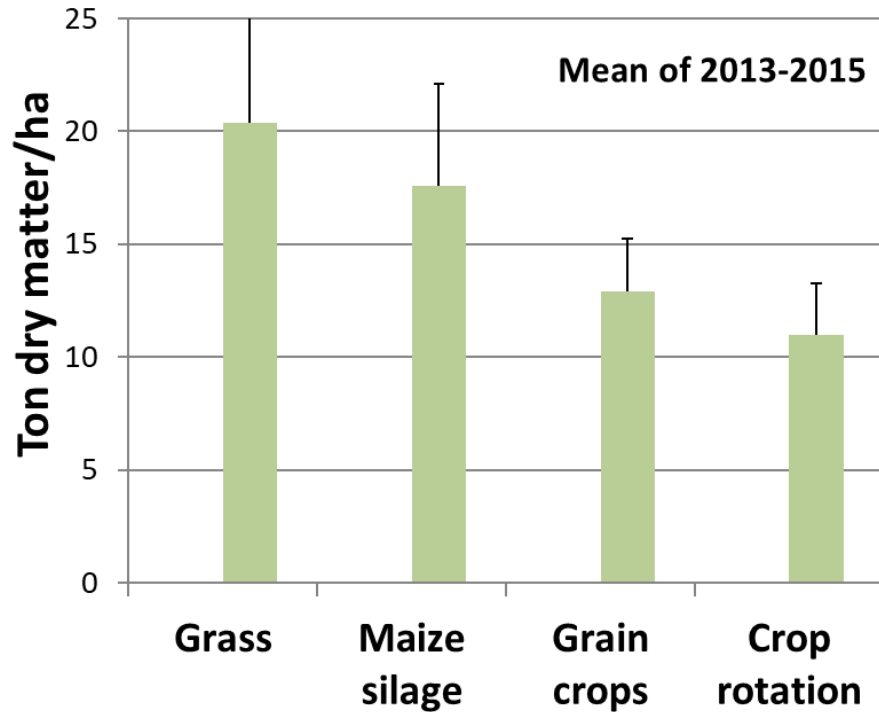
Example



**Fields can look this different in autumn
– we decide**



Biomass production can be doubled and nitrate leaching halved



Manevski et al., 2017; 2018

Other environmental benefits from conversion of annual crops to grass

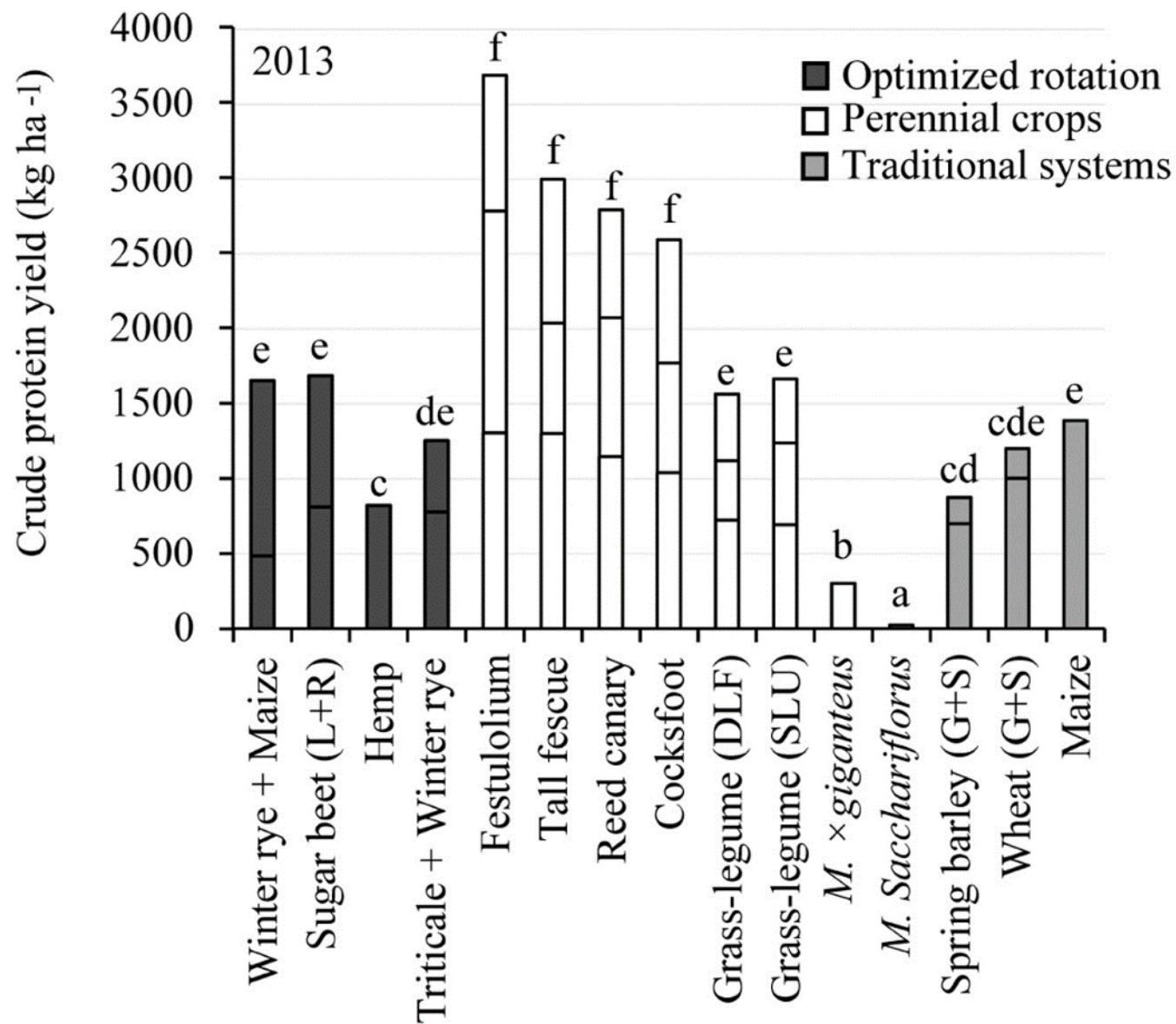
- Reduced soil erosion
- Reduced GHG emission (0.5-3.5 ton CO₂-equiv/ha)
- Reduced pesticide use (by factor 40-50)
- Increased biodiversity



So, what to do with all that grass?

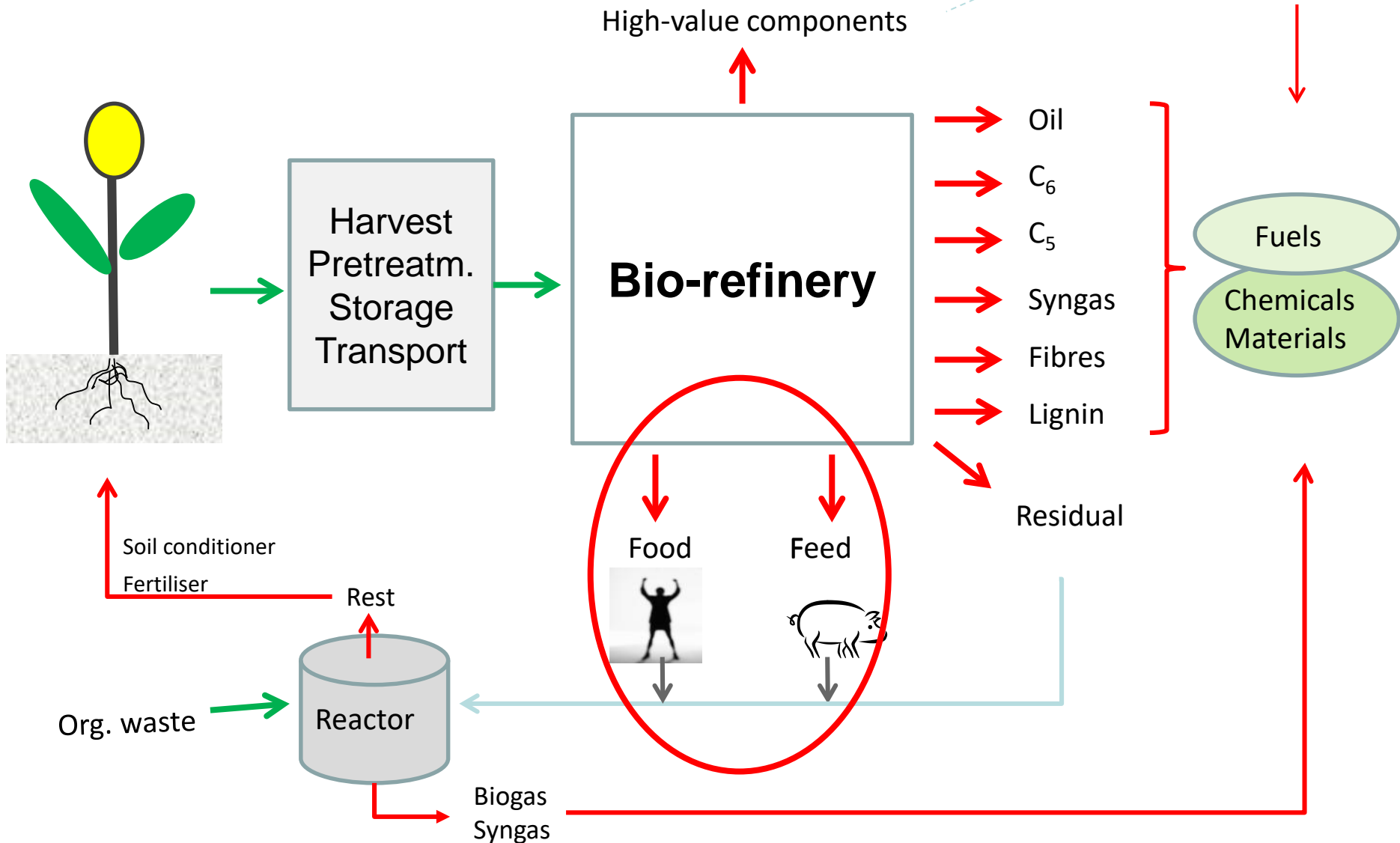


Crude protein yield higher in grasses than in other crops



A radical new crop production paradigm can be un-locked by green biorefineries

Colours
Flavors
Medicin
Other chemicals







Feeding experiment with green protein to pigs, cows, broilers & egg layers



Business evaluation of decentralized green biorefineries in Denmark

Economic assumptions:

- Biorefinery CAPEX : 3.36 mio EUR
- Depreciation time: 15 year
- 5% Interest rate , 5% Maintenance
- Grass price
- Organic: 0.15 EUR/kg
- Conventional: 0.13 EUR/kg
- Protein concentrate price
- Organic: 0.67 EUR/kg
- Conventional: 0.34 EUR/kg
- Fiber pulp price
 - Identical to grass price
- Residue juice is not given any cost or value - It is used for internal energy production at the biogas plant.

Economy	Scenario	
	Organic	Conventional
	Mio. EUR	Mio. EUR
Income		
Protein concentrate + Fibre	4.70	3.25
Expenses		
Grass	3.33	2.90
Energy and salary	0.19	0.19
Maintenance	0.17	0.17
Depreciation and interest	0.32	0.32
Result	0.66	-0.34

Source: Morten Ambye-Jensen

Green biorefinery can develop agriculture in a sustainable way because

- Grass can approx. double productivity while nitrate leaching, pesticide use, GHG emission & soil erosion is reduced
- Extracting the high protein content in grass & legumes while the fibre is fed to dairy cattle creates a new market for grass
- The fibre fraction may also be used for biogas, fermentation, textiles, or.....
- Feeding trials on mono- and poly-gastric animals are promising
- The business case for organic production is positive
- It is a cheaper way to fulfil e.g. the EU Water Framework Directive than existing measures often reducing productivity

Demo-plant for green biorefinery now ready to pave the way for market introduction

Supported by public funding and Arla, Danish Crown, DLG & DLF



BI  VALUE SPIR



CBIO
AARHUS UNIVERSITY CENTRE FOR
CIRCULAR BIOECONOMY



Interreg
Öresund-Kattegat-Skagerrak
European Regional Development Fund



Green Valleys

JOINT COMMERCIAL GREEN BIOREFINERY PROJECT APPLIED WITH DUEHOLM EGG

Budget: 20 m DKK from 2020-2024

5 work packages:

- ☐ Harvest of green juice/paste in a mobile harvesting machine
- ☐ Storage, logistics and blending of green juice/paste for feeding hens
- ☐ Quality and health of eggs from hens fed with green juice/paste
- ☐ Optimal crop production and cycling of nutrients in organic egg production
- ☐ Possibilities for sale and marketing of healthy eggs in China etc.

