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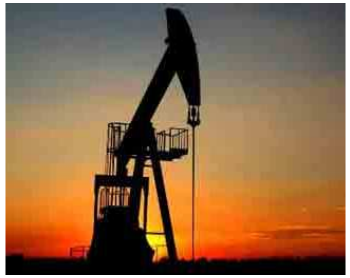
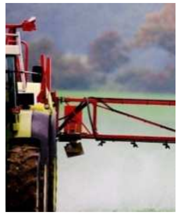
Reducing greenhouse gas emissions of pig production through feed production and diet formulation



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From: M. Meul, C. Ginneberge, D. Fremaut, C.E. Van Middelaar, I.J.M. de Boer, G. Haesaert. 2012. Carbon footprint of five pig diets using three land use change accounting methods. Livestock Science, *in press*.

Diets

STAND ‘Standard’ feed composition for fattening pigs

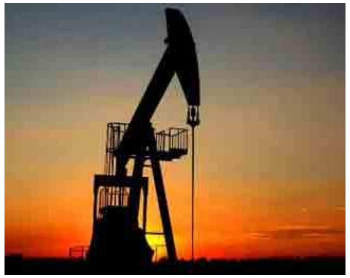
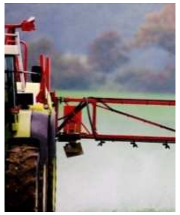
CROP 10% increased crop yield with equal inputs

10% decrease in crop fertilisation assuming equal yields

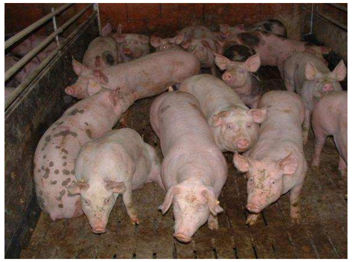
EU European grown feed ingredients only

BY-P maximum use of by-products from food and bio-energy industry

N-LOW limited crude protein content





Diets

	STAND/CROP	EU	BY-P	N-LOW	
feed composition (%)					
maize	27.7	25.9	9.3	20.1	
barley	24.9	14.7	0.0	22.5	
peas	14.5	15.0	15.0	0.0	
soybean meal (SBM)	10.3	0.0	0.0	1.6	< Brazil
rapeseed meal (RSM)	7.8	12.0	0.0	12.0	
wheat	6.4	19.7	40.0	33.9	
sugar beet pulp (SBP)	4.0	0.0	5.0	4.0	
lupins	0.0	8.3	0.0	0.0	
DDGS	0.0	0.0	15.0	0.0	
maize gluten feed (MGF)	0.0	0.0	10.8	0.0	
soybeans	0.0	0.0	0.0	1.1	< Brazil
synthetic amino acids	0.01	0.17	0.52	0.49	
minerals and vitamins	4.5	4.3	4.4	4.4	
crude protein content (%)	15.7	15.3	15.9	13.0	
P content (%)	0.47	0.47	0.47	0.47	

All diets are nutritionally equivalent → no problem shifting to pig fattening stage

Methods and data

CFP (kg CO_2-eq/ton compound feed) = 1x kg CO_2 + 25 x kg CH_4 + 298 x kg N_2O

Attributional LCA

Economic allocation

Primary data, secondary data from scientific literature, Ecoinvent (2010)

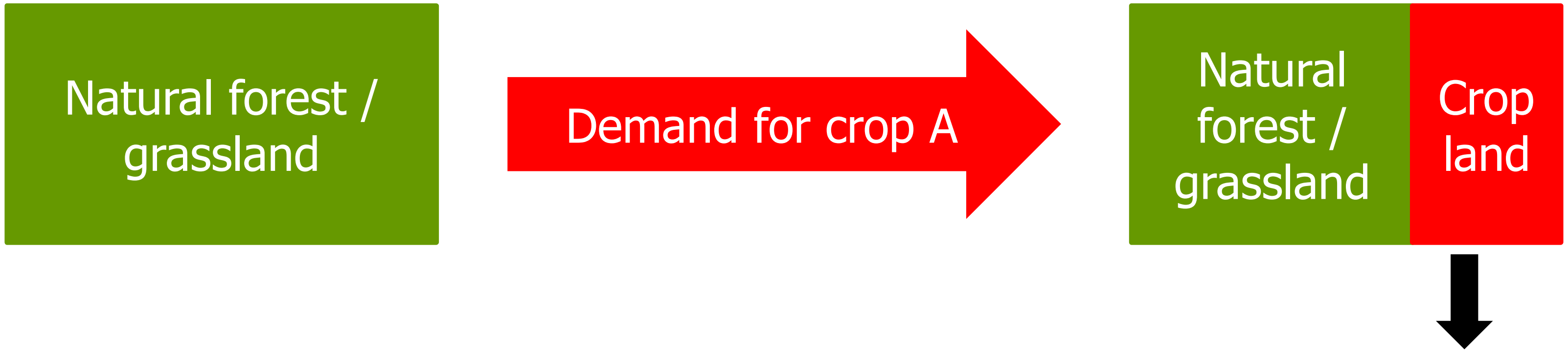
Considered processes for all diets:

- Crop production: production of used synthetic fertilizers, lime, pesticides and field machinery; diesel used during field activities; direct and indirect N_2O-emissions and CO_2-emissions from liming
- Processing of harvested crops to feed ingredients
- Production of compound feed
- Transport

→ Reference CFP

Methods and data

CFP including emissions from direct land use change



Direct LUC related to crop A = Emission of GHGs due to decrease in carbon stocks in above and below-ground biomass, dead organic matter and soil

E.g. 2081 kg CO_2-eq/ha soybeans based on deforestation rates from Jungbluth et al. (2007) and using IPCC (2006) methodology

e.g. Round Table on Responsible Soy → only use soybeans from not recently deforested land

Methods and data

Cropland for feed/food/bio-energy

→ Demand for crop A →

Cropland for feed/food/bio-energy **+ crop A**

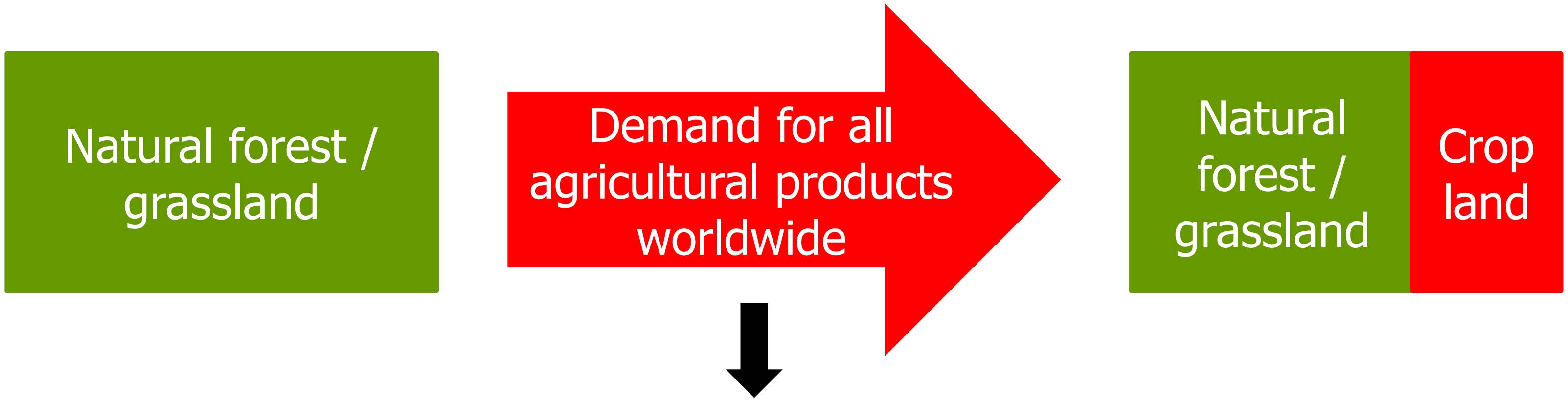
↓

Indirect LUC related to crop A = Former agricultural production can be displaced to other areas, some of which will be converted from other land use types

→ CFP including emissions from only direct LUC is not able to account for the full LUC effects associated with a diet.

Methods and data

CFP including emissions from total LUC risk



Total LUC risk =

all emissions from land use change caused by commercial agriculture worldwide, allocated to products based on their land use

= 1430 kg CO2-eq/ha (Audsley, 2009)

→ does not allow to distinguish between feed ingredients with equal land use requirements, but different LUC impacts

Results

	Reference CFP (kg CO_2-eq ton^{-1})				dLUC	Total LUC risk	Land use
	crop production	processing	transport	total	kg CO_2-eq ton^{-1}		m^2 ton^{-1}
Barley	327	10	20	357	0	174	1216
SBP [a]	54	755	37	846	0	20	138
Lupins	370	10	20	400	0	545	3811
Maize	368	10	20	398	0	124	868
Peas	447	10	20	477	0	507	3543
RSM [a]	396	25	16	437	0	163	1143
Soybeans	332	10	242	584	784	546	3818
SBM [a]	265	85	205	555	627	437	3055
Wheat	420	10	20	450	0	153	1072
MGF [a]	160	128	30	318	0	54	378
DDGS [a]	267	360	33	660	0	98	682
SAA [a]	-	-	-	3600	-	0	0

Results

	Reference CFP		CFP including dLUC		Land use		Total LUCrisk		CFP including total LUC risk	
	average	% of STAND	average	% of STAND	average	% of STAND	average	% of STAND	average	% of STAND
STAND	452		517		1534		219		671	
CROP										
yield +10%	426	94	485	94	1395	91	199	91	625	93
mineral fertilizer -10%	432	96	497	96	1534	100	219	100	651	97
EU	437	97	437	85	1599	104	229	104	666	99
BY-P	513	113	513	99	1191	78	170	78	683	102
N-LOW	461	102	479	93	1041	68	149	68	610	91

CROP diet has lowest CFP

EU diet has lowest CFP

N-LOW diet has lowest CFP

Conclusions

→ CFP of pig diets can be lowered through optimization of crop production and formulation of diets

→ Accounting for greenhouse gas emissions associated with direct LUC and total LUC risk has a major impact on the results

→ We propose to apply **two decision rules** when trying to formulate diets with low carbon footprints:

(1) avoid direct land use change as much as possible and

(2) minimize carbon footprint including total land use change risk