



# Emission scenarios for biofuel crop production in Denmark 2010-2030

## Indirect land use changes of biofuel production and the impacts on emissions of N, P and pesticides

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## Intro · methods · results ·

Global focus on renewable energy, biofuels

EU biofuels directive

10% blend by 2020

Domestic production of biomass or import?

Domestic! – iLUC, ethics, increase self-sufficiency



## Intro · methods · results·

### Short story

*transport demand → energy demand → biofuel demand →  
areas for production*

*DK intensively cultivated → biofuel crops replace present  
cropping patterns*



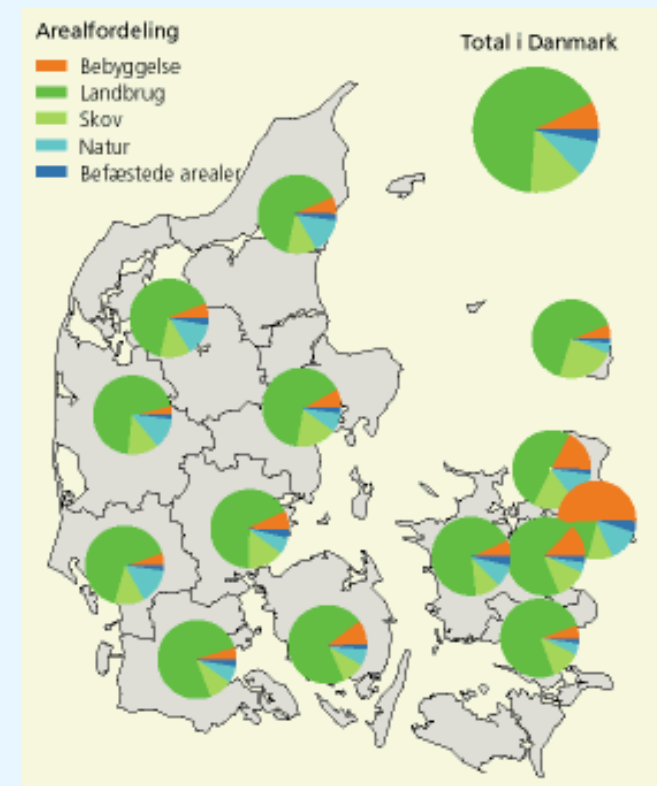
## Intro · methods · results ·

### Short story

*DK land surface dominated by  
agriculture*

*Large livestock production*

*large areas for fodder production*





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Short story (sort of..)

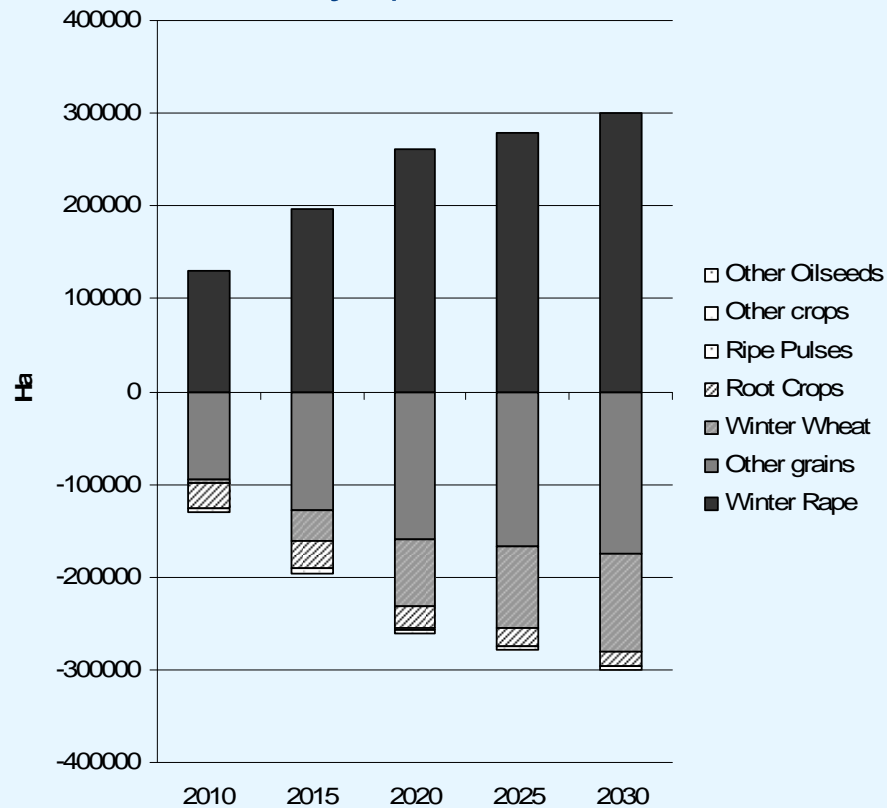
*Competition for area between current agr. practices and  
biofuels = **pigs vs. biofuel crops***





## Intro · methods · results ·

### Short story (but not than short any longer)





## Intro · **methods** · results·

### Emission estimates – aquatic N & P, pesticides

$$Ex = \sum_i^n \sum_j^n LU_{ij} \cdot (Ex_j - Ex_i)$$

$Ex$  = emissions of  $x$  (Nitrogen, Phosphorous or active ingredients in pesticides)

$LU_{ij}$  = change in hectares from crop  $i$  to crop  $j$  and

$(E_j - E_i)$  = emission changes of either N, P or application of pesticides associated with land use change from crop  $i$  to crop  $j$



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### Emission estimates – atmospheric N

$$NH3_{manure} = \Delta pig \cdot (N \cdot pig^{-1}) \cdot C_{NH3pigs}$$

$NH3_{manure}$  = ammonia emissions from pig manure

$\Delta pig$  = the change in the pig herd

$N$  = the total nitrogen produced by pigs in Denmark and

$C_{NH3pigs}$  = the  $NH3$  emission coefficient for pig manure.



## Intro · **methods** · results·

### Emission estimates – atmospheric N

$$NH3_{fertilizer} = \Delta pig \cdot (N \cdot pig^{-1}) \cdot C_{NH3\ fertilizer}$$

$NH3_{fertilizer}$  = ammonia emissions from inorganic fertilizer

$\Delta pig$  = the change in the pig herd

$N$  = the total nitrogen produced by pigs in Denmark and

$C_{NH3pigs}$  = the  $NH3$  emission coefficient for inorganic fertilizer.



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### N, P & Pesticides

Major land use change: expansion of rape seed, decrease in wheat and minor categories

	<b>N leached</b>	<b>P surplus</b>	<b>Pesticides applied</b>
<b>Cereals, spring-</b>	<b>65.27</b>	<b>-2</b>	<b>0.51</b>
<b>Rape, winter-</b>	<b>77.37</b>	<b>1</b>	<b>0.23</b>

All figures in kg/ha



## Intro · methods · **results** ·

### N, P & Pesticides

$$Ex = \sum_i^n \sum_j^n LU_{ij} \cdot (Ex_j - Ex_i)$$

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All figures in kg/ha



## Intro · methods · **results** ·

### N, P & Pesticides, change in 2030

$$E_n = 5,720 \text{ tonnes yr}^{-1}$$

$$E_p = -467 \text{ tonnes yr}^{-1}$$

$$E_{ai} = -215 \text{ tonnes yr}^{-1}$$



## Intro · methods · **results** ·

### N atmospheric

Decrease in fodder area -> decrease in pig population  $\approx$  2.8 mio pigs

	Organic manure	Inorganic fertilizer
N Production per head per year	7.85 kg	
Kg NH <sub>3</sub> /kg N input	0.149	0.0225
Kg N <sub>2</sub> O/kg N input	<b>0.195</b>	<b>0.195</b>



## Intro · methods · results·

### N atmospheric

Decrease in fodder area -> decrease in pig population  $\approx$  2.8 mio pigs

- 3.276 tonnes

$$NH3_{manure} = \Delta pig \cdot (N \cdot pig^{-1}) \cdot C_{NH3\ pigs}$$

	Organic manure	Inorganic fertilizer
net change	- 2.905 tonnes	
N Production per head per year	7.85 kg	
Kg NH3/kg N input	0.149	0.0225
Kg N2O/kg N input	0.195	0.195

$$NH3_{fertilizer} = \Delta pig \cdot (N \cdot pig^{-1}) \cdot C_{NH3\ fertilizer}$$



## Intro · methods · results·

### Summary

Compliance with EU's biofuels directive:

- demand for areas for biofuel crop cultivation
- change in current cropping patterns: incr. rape, decr. fodder (wheat)
- increasing N leaching to the aquatic environment, less P, a.i.
- decreasing pig pop., less manure → less  $\text{NH}_3$



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Thanks for your attention