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Life cycle assessment of organic milk production in Denmark

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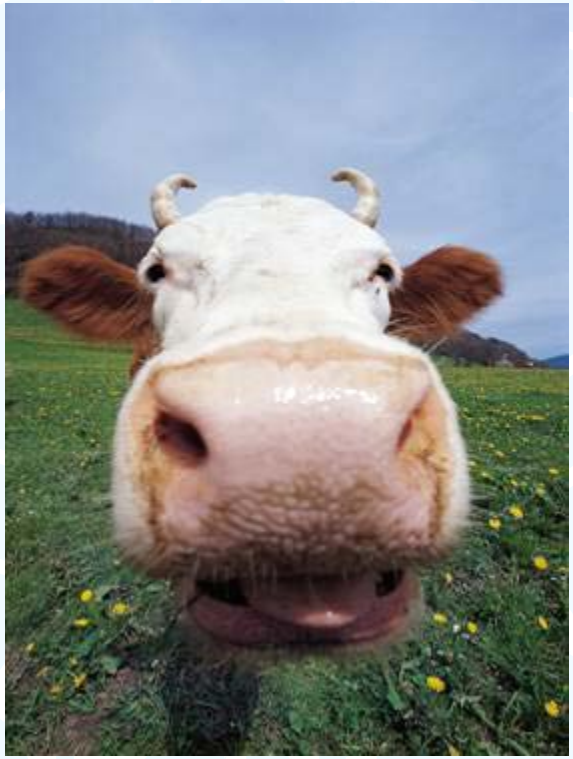

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Outline of the presentation

- Introduction
- Aim of the study
- Materials
  - An organic dairy farm in Denmark
- Methods
  - Life cycle assessment (LCA)
- Results
- Improvement options
- Conclusion

Aim of this study

Estimate the GreenHouse Gas (GHG) emission of Danish organic milk through Life-Cycle Assessment (LCA) based on data that typically are available at the farm

Suggest possibilities for reduction of the GHG emission on farm gate

Materials

Typical annual data from an organic dairy farm:

- Economic turnover
- Manure account
- Production performance

The herd

	Cows	Heifers	Bull calves
No.	192	297 [3]	142 [1]
Milk yield, kg	9000		
Housing	Cubicles	Deep litter	Deep litter
Summergrazing	8 h per day	24 hours [2]	0

1) Sold at 60 kg
2) For heifers > 6 months
3) High number due to extended the herd size

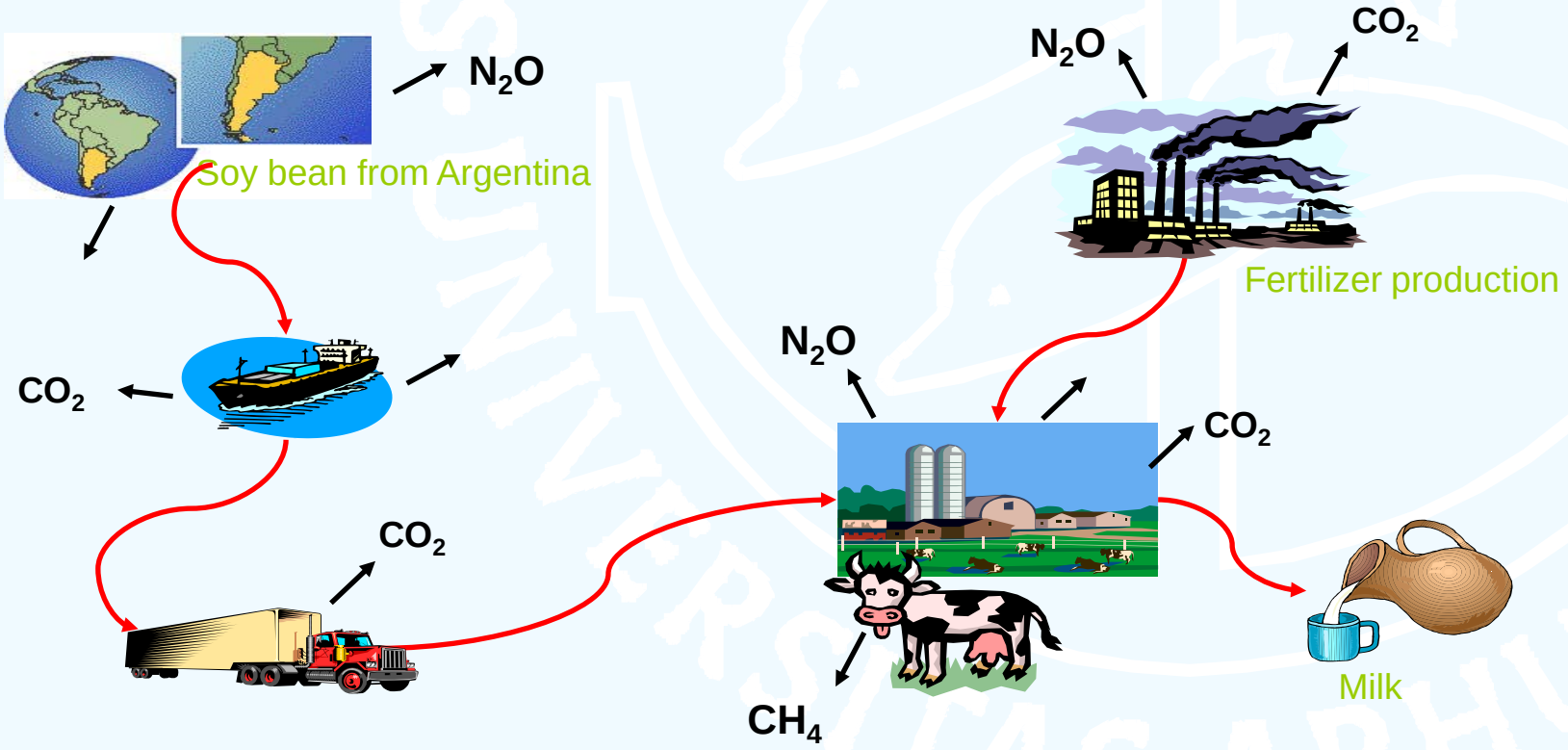
The fields

320 ha in rotation on sandy soil
21 ha permanent pasture

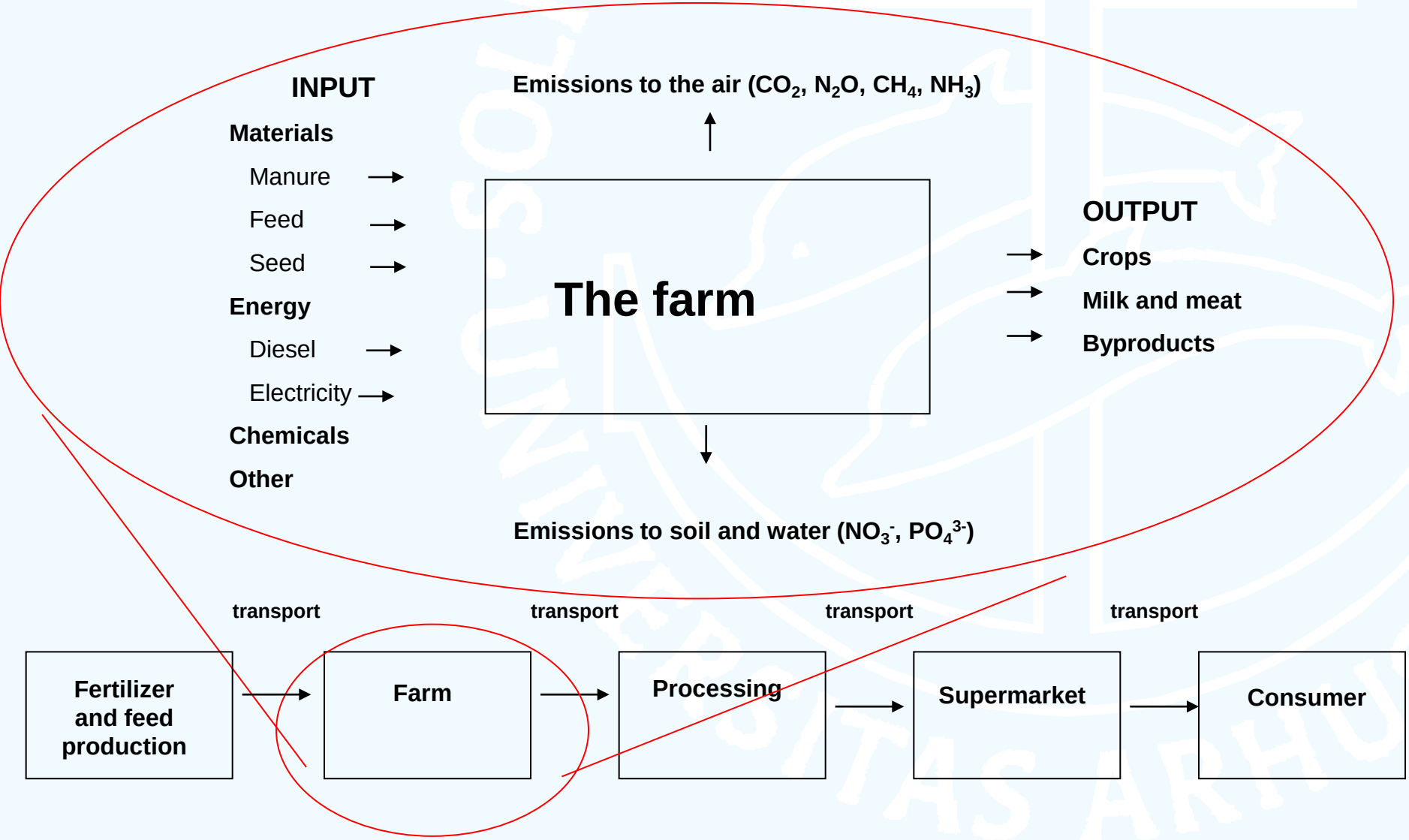
	Ha	%
Grass clover	128	40
Cereals for whole crop	77	24
Cereals for maturity	104	33
Carrots	10	3

Methods

Life cycle assessment (LCA)



The system boundaries:



Functional unit (FU)

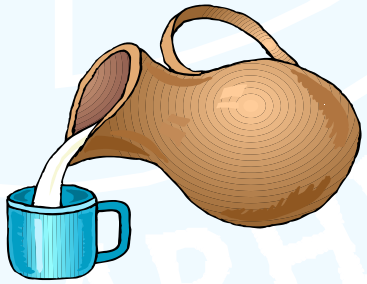
1) GHG emission of the whole farm

(kg CO_2-eq/farm/year)

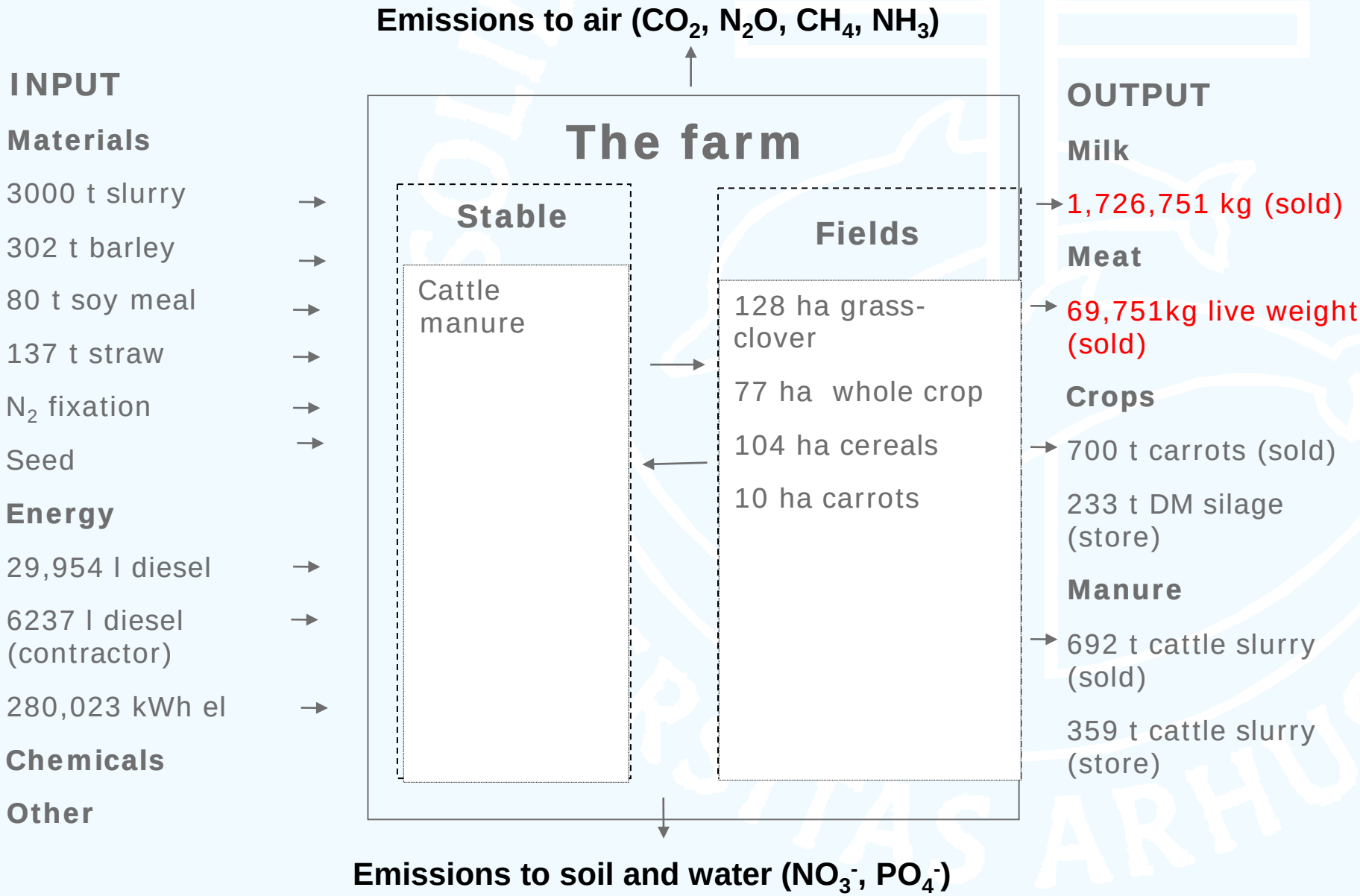
2) After biological allocation:

GHG per 1 kg milk ex farm

(kg CO_2-eq/kg milk)



Inventory: Input and output



CO_2 emission from external input

Input of	CO_2-eq emission, kg
1 kg barley	0.694
1 kg soy bean meal	0.934
1 kg N_{plant} from manure	9.120
1 litre diesel	3.309
1 kWh electricity	0.655

CH_4 emission estimation

CH_4, kg	Area	Amount	Emission Factor
	Enteric fermentation	Kg DMI x 18.45 MJ/kg DM / (55.65 MJ/kg CH_4)	0.06
	Manure	Non-digestible organic DMI + organic matter used as bedding CH_4 formation capacity=0.22	
	- slurry		0.1
	- deep litter		0.01
	- pasture		0.01

(IPCC, 2006)

N_2O emission estimation

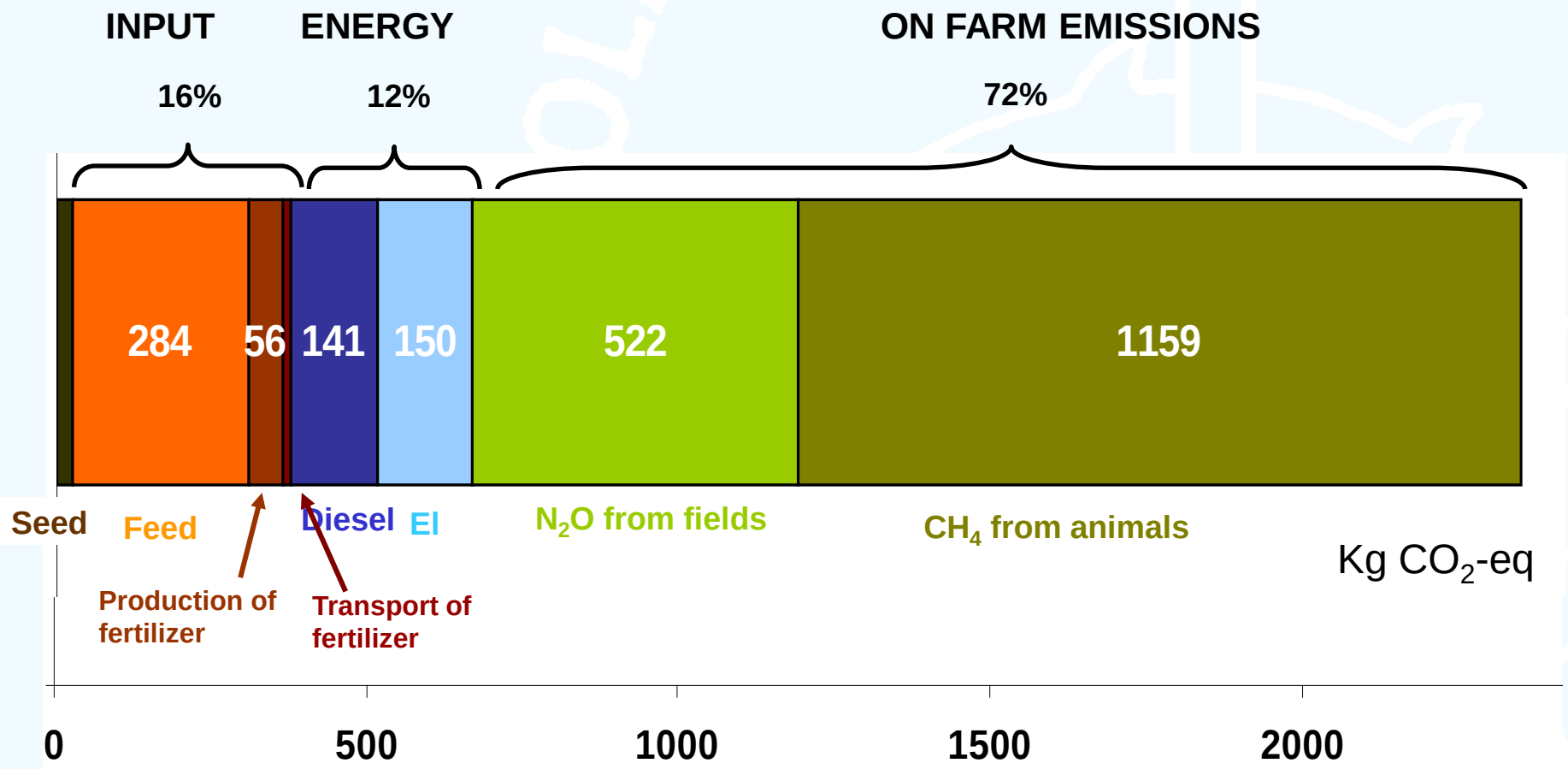
N_2O, kg direct	**Area**	**Amount**	**Emission Factor**
	Stable & storage	N manure ex animal	
	- slurry		0.005
	- deep litter		0.01
	Application	N manure ex storage	
	- manure		0.01
	- pasture		0.02
	Crop residues	Sum ha * kg N per ha per year Grassland 50 N Other arable crop 30 N	0.01
Indirect N_2O	From **NH_3**	NH_3-N	0.01
	From **leacing**	$N0_3$-N=0.33*(N manure ex storage+N import fertilizer)	0.0075

(IPCC, 2006)

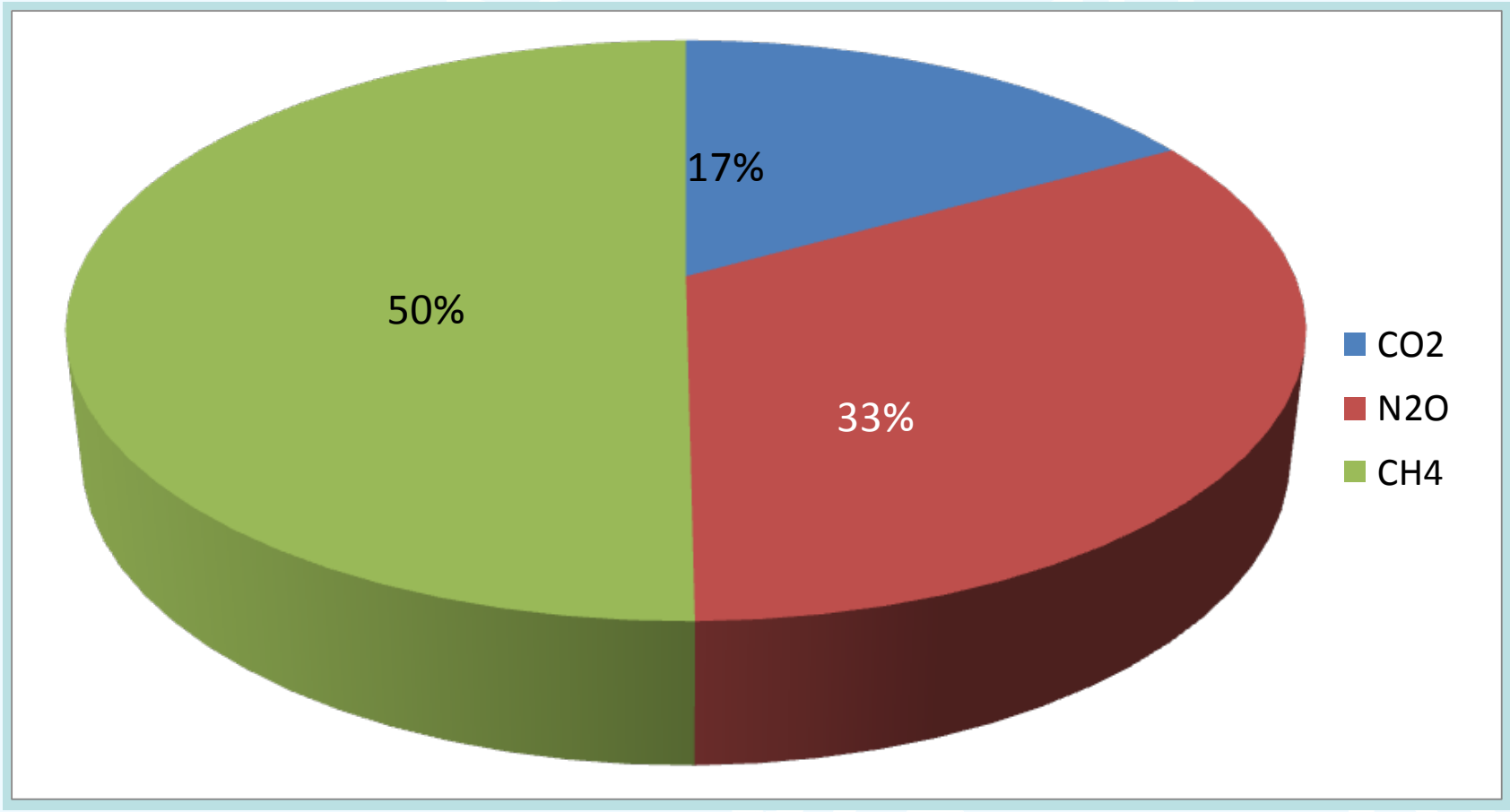
Total farm GHG emission

	Kg CO_2-eq.
Total farm GHG	2,347,600
Per ha	6,880
Per kg milk – before allocation	1.36
Per kg milk – allocated	1.02
Per kg meat – allocated	16.1

GWP hotspots



Contribution per GHG



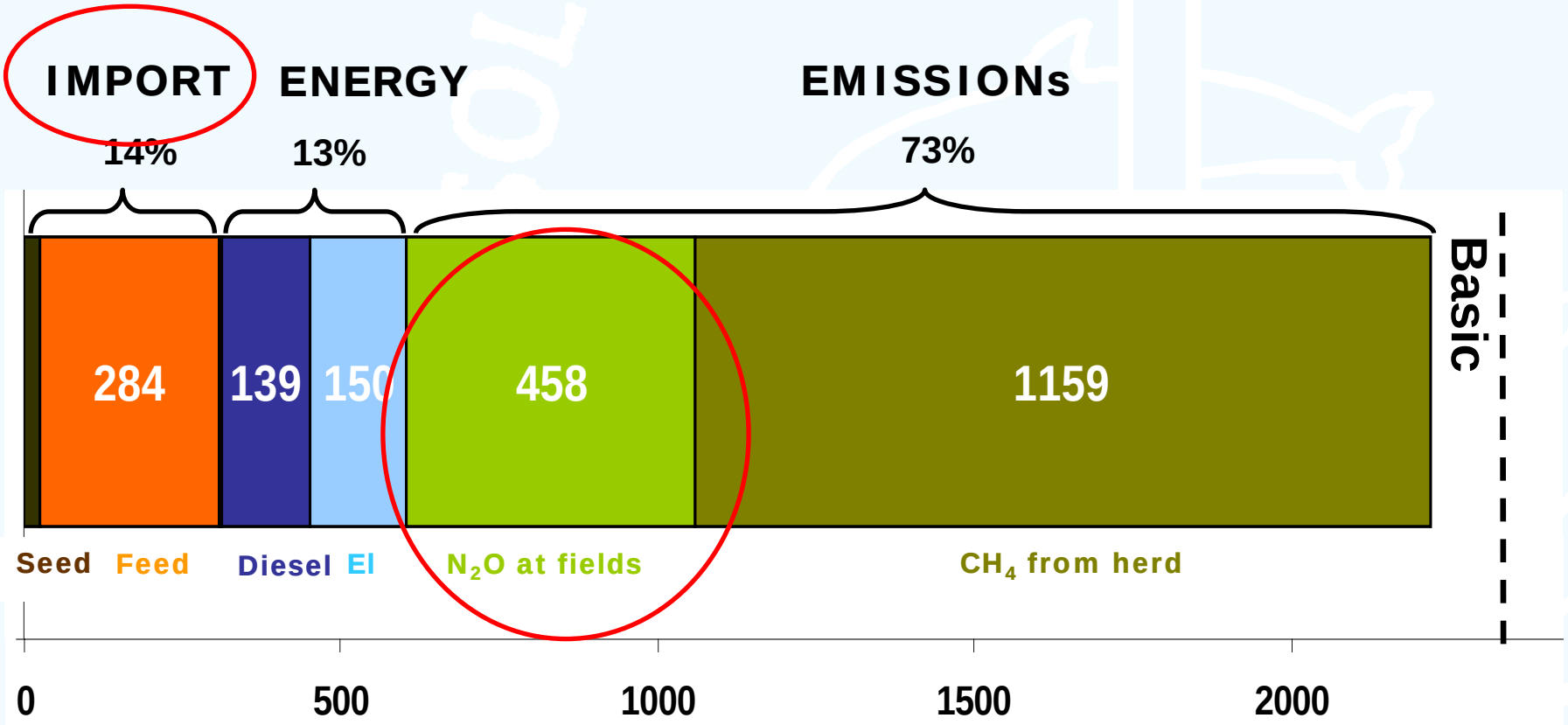
Improvement options
Increased N efficiency

Reduced N application: 140 to 115 kg N/ha

Import of N reduced by 8,000 kg

Crop yield at same level

Total farm GHG reduced by 5%



Conclusion

Farm GHG can be calculated based on typical farm data

Improvement in farm GHG in the present case: 5% of total

Farm GWP only one of several impact categories in a LCA (acidification, nutrient enrichment, land use etc.)