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Impact of Organic farming on aquatic environment

By

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DARCOF

DARCOF

(Danish Research Centre for Organic Farming)

Presentation of DARCOF

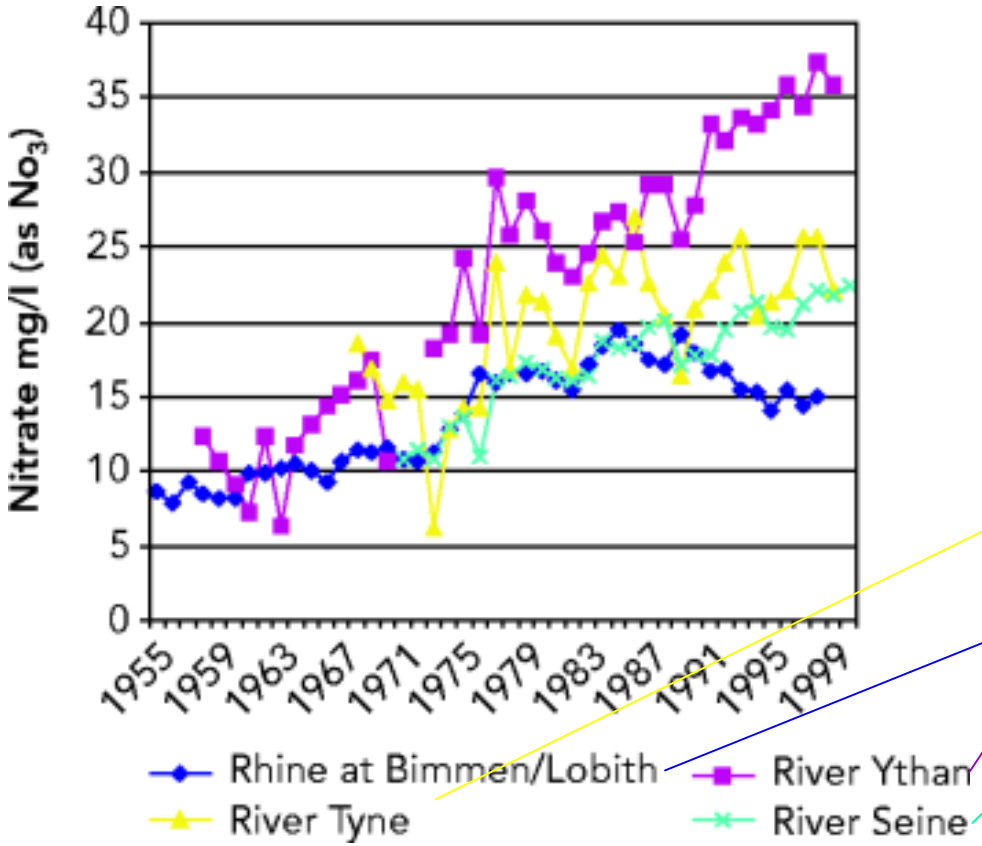
- Established in 1996 by the government
- Initiate and coordinate R & D in organic agriculture
- Communicate the results and contribute to further education
- “Centre without walls”: 20 Institutes, 140 Scientists
- 30-50 research projects, 40-60 mill Dkr (5-8 mill €) per year

Outline

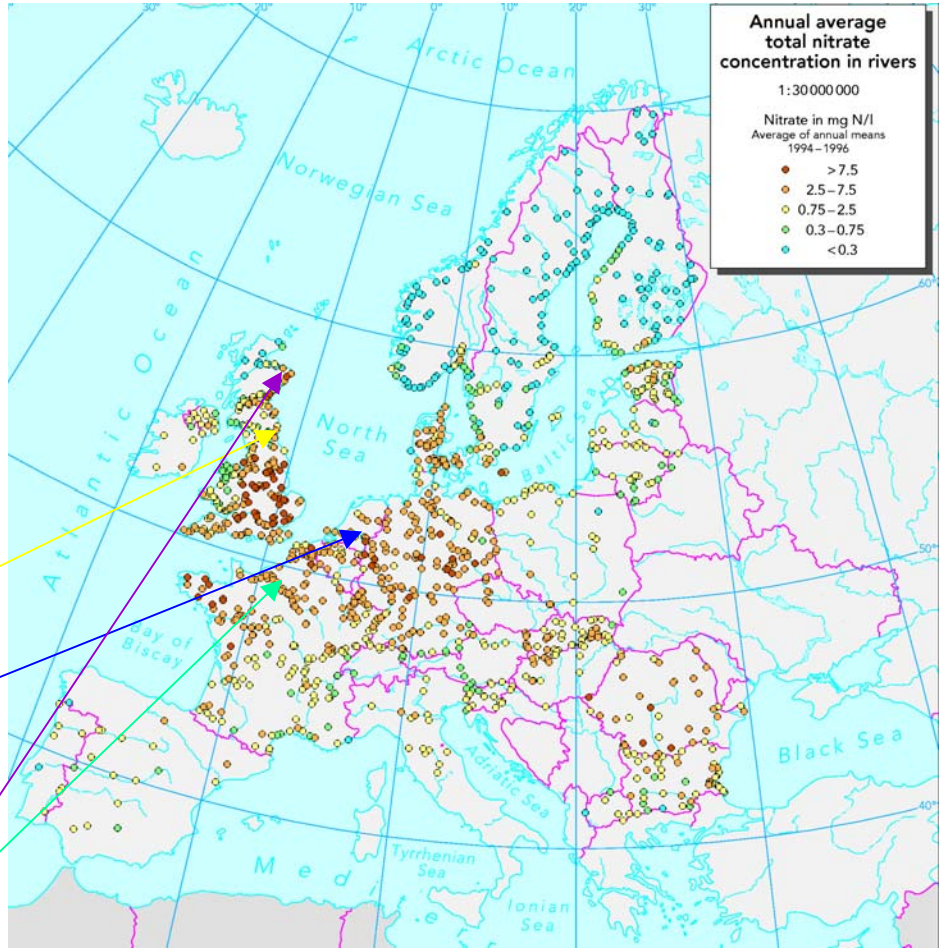
1. Problems in European aquatic environment
2. Development in organic farming
3. Effect of conversion to organic mixed/dairy farming
4. Effect of conversion to organic arable farming
5. Conclusion

Nitrate concentration in European rivers

Development since 1955



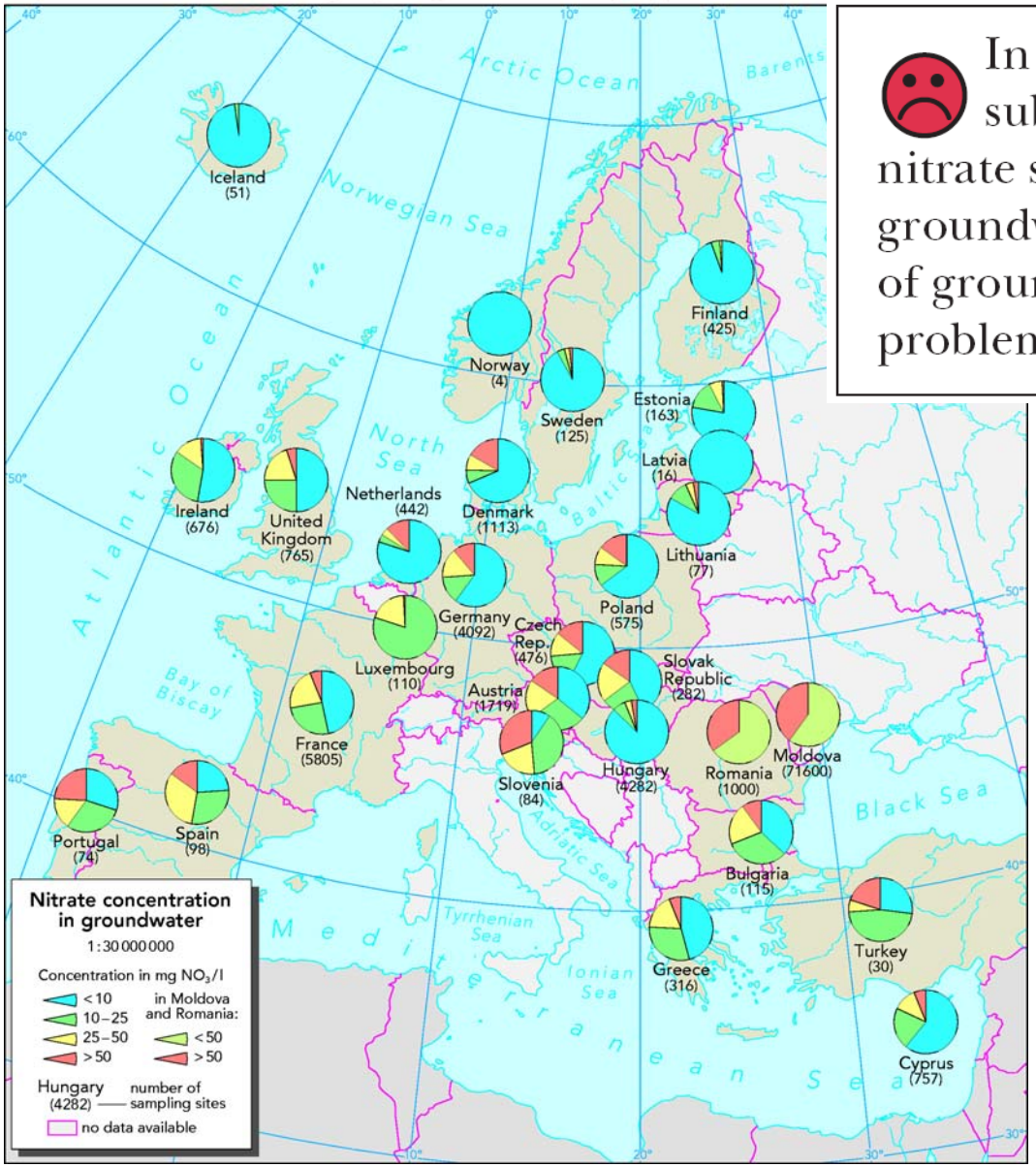
Extension 1994-96



Source: European Environment Agency (http://dataservice.eea.eu.int/atlas/viewdata/viewpub.asp?id=546)

Nitrate in groundwater

Map 9.4 Nitrate concentration (mg NO_3/l) in groundwater – frequency distribution at a country level.

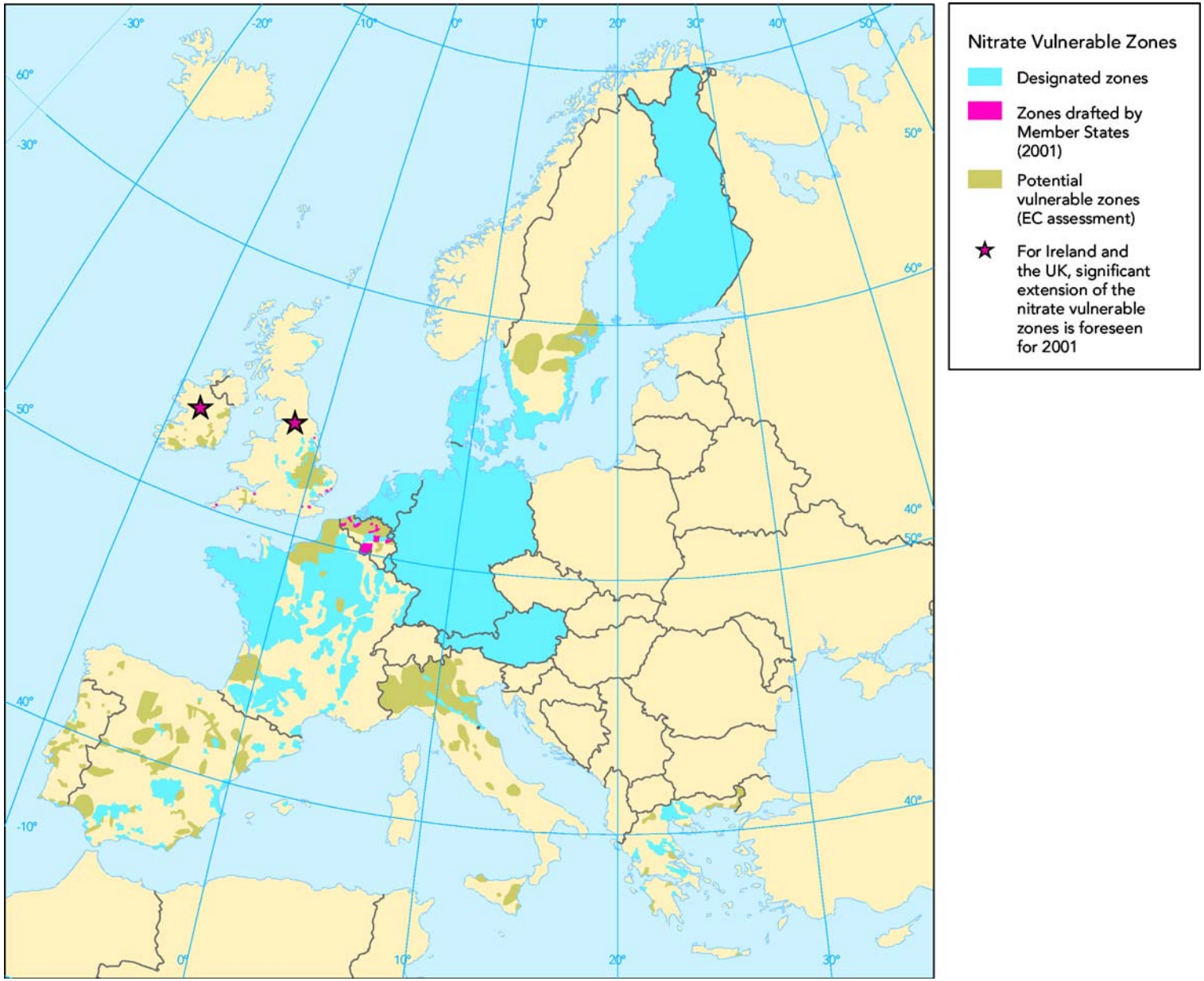


In general, there has been no substantial improvement in the nitrate situation in European groundwater and hence nitrate pollution of groundwater remains a significant problem.

European Environment Agency, 2003

Source: European Environment Agency (http://dataservice.eea.eu.int/atlas/viewdata/viewpub.asp?id=110)

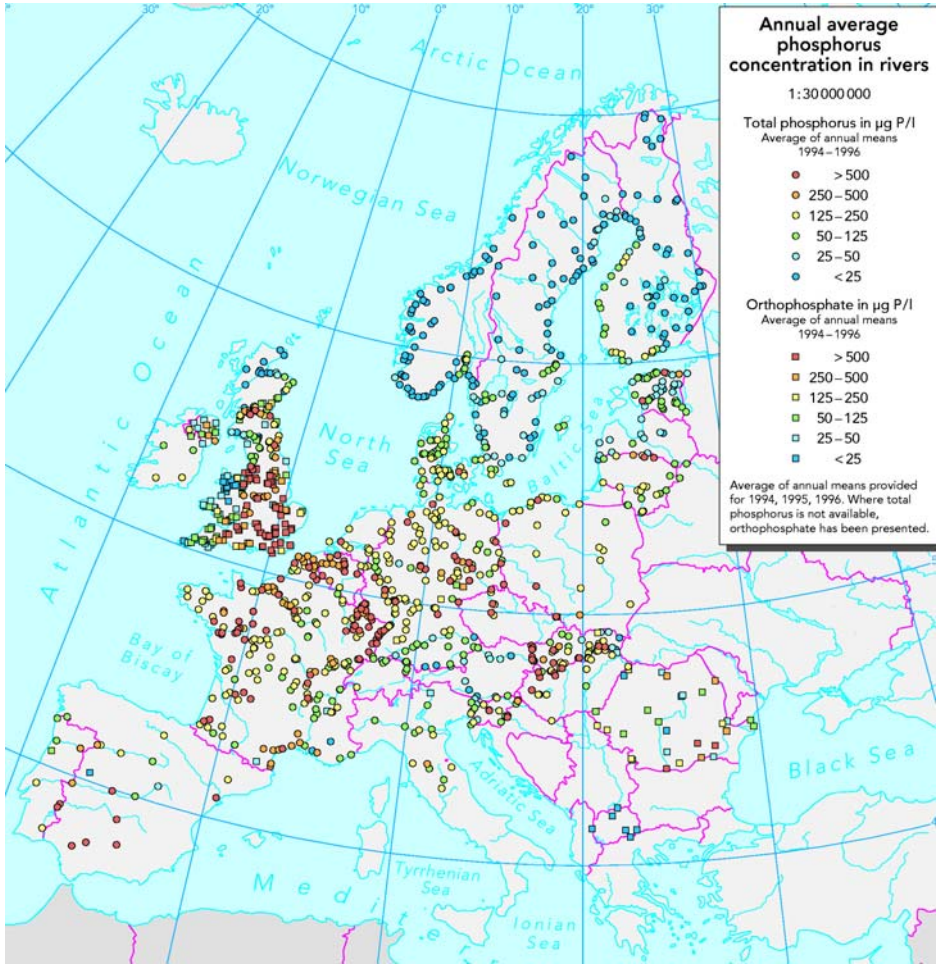
Nitrate Vulnerable Zones



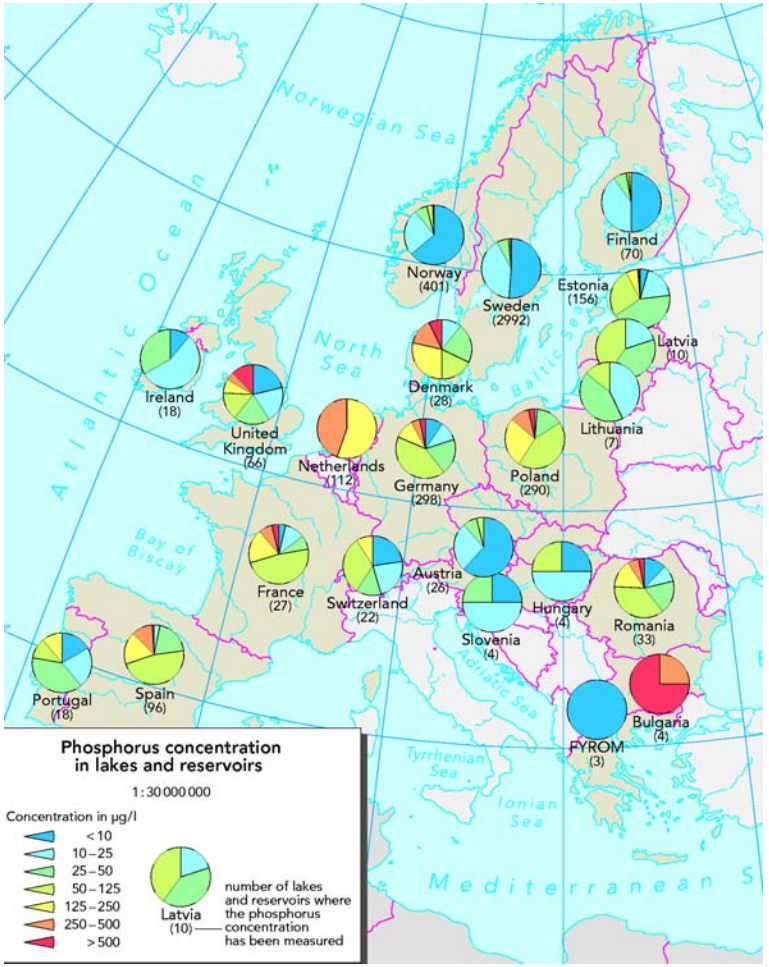
Source: European Environment Agency (http://dataservice.eea.eu.int/atlas/viewdata/viewpub.asp?id=150)

Phosphorus concentration in European rivers og lakes

Rivers (1994-96)



Lakes and reservoirs



Source: European Environment Agency (http://dataservice.eea.eu.int/atlas/viewdata/viewpub.asp?id=546)

Status of European waters

Indicators	Assessments	
Nitrate in groundwater		No decrease (or increase) in levels of nitrate in Europe's groundwater.
		Nitrate drinking water limit values exceeded in one third of the groundwater bodies.
		Nitrate in drinking water a common problem across Europe.
Nutrients in rivers		Concentrations of phosphate have decreased in the rivers of the EU and accession countries during the 1990s.
		Nitrate concentrations in rivers stable throughout the 1990s - highest in western Europe where agriculture is most intensive.
Phosphorus in lakes		Eutrophication of European lakes is decreasing.
		Still many lakes and reservoirs with high concentrations of phosphorus - highest in accession countries.
Nutrients in marine waters		Nutrient concentrations in Europe's seas have generally remained stable over recent years.

European Environment Agency, 2003

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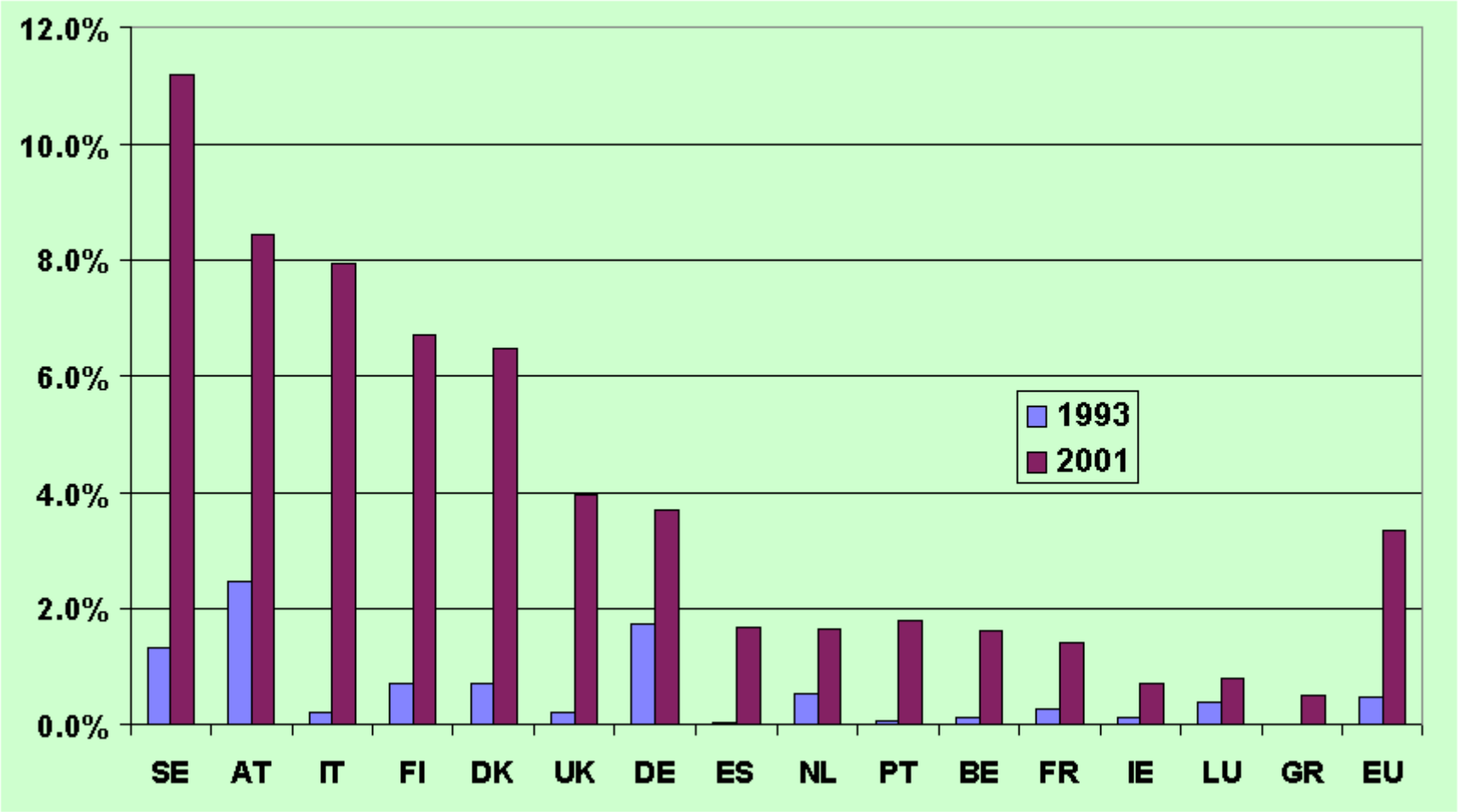
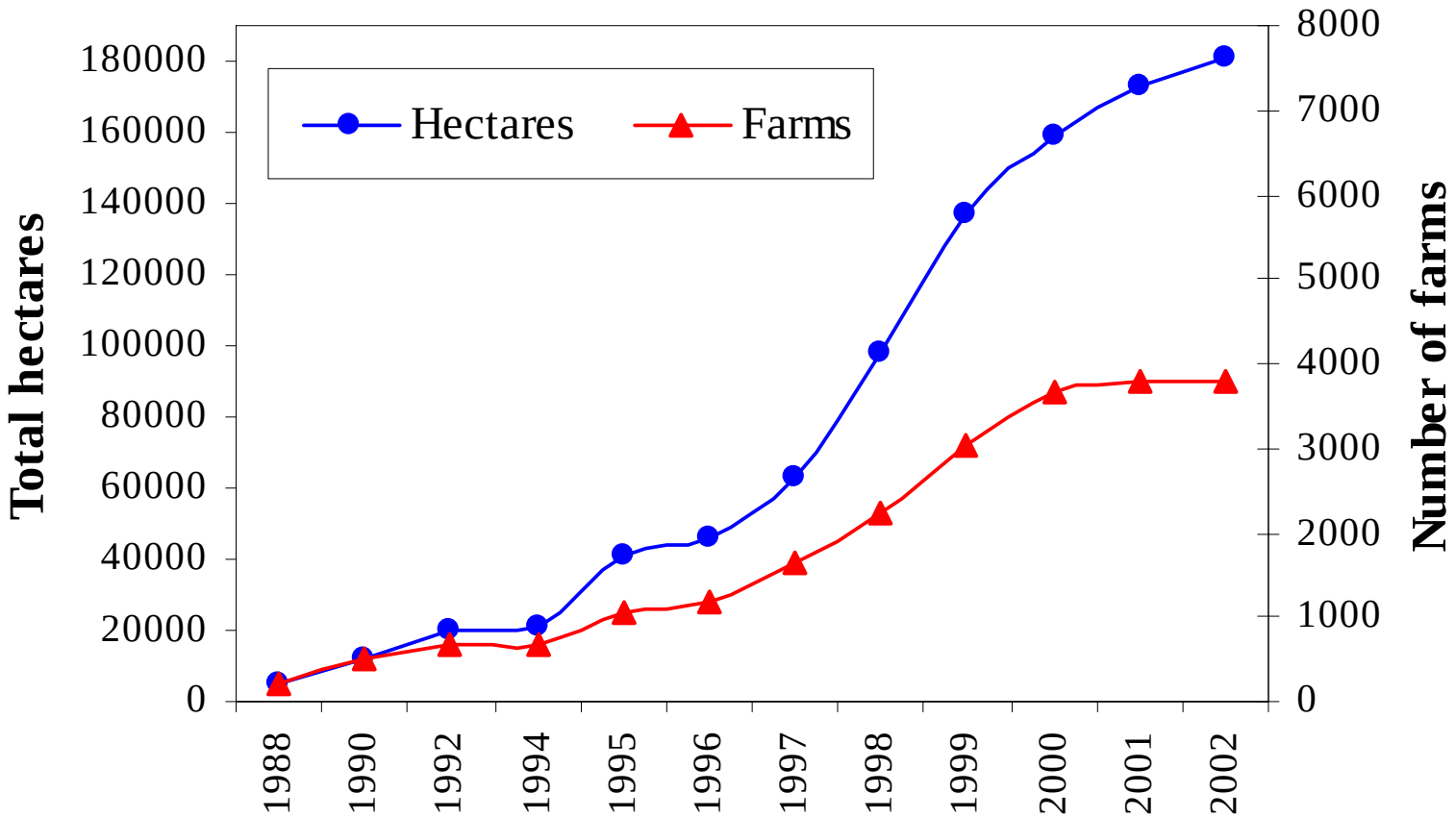
Development of organic farming in EU-15 countries



http://www.organic.aber.ac.uk/stats.shtml

Development of organic farming in Denmark



Organic farms in Denmark 2003

Farm types	Number	Area, ha			Land use					
		Per farm	Total	%	Live-stock units/ ha	Cereals, maturity	Silage (maize + pea/ barley)	Clover/ grass	Others	Perma-nent grass
Organic, total	*3700*	*48*	*178.000*	*6,4*						
Mixed/dairy farms	**770**	**115**		**50**	**1,28**	**15**	**28**	**42**	**0**	**13**
Arable farms	**530**	**83**		**25**	**0,07**	**59**	**10**	**15**	**11**	**5**
Others (incl. pigs/poultry)	**2400**	**19**		**25**	**0,65**					

(Plantedirektoratet 2003)

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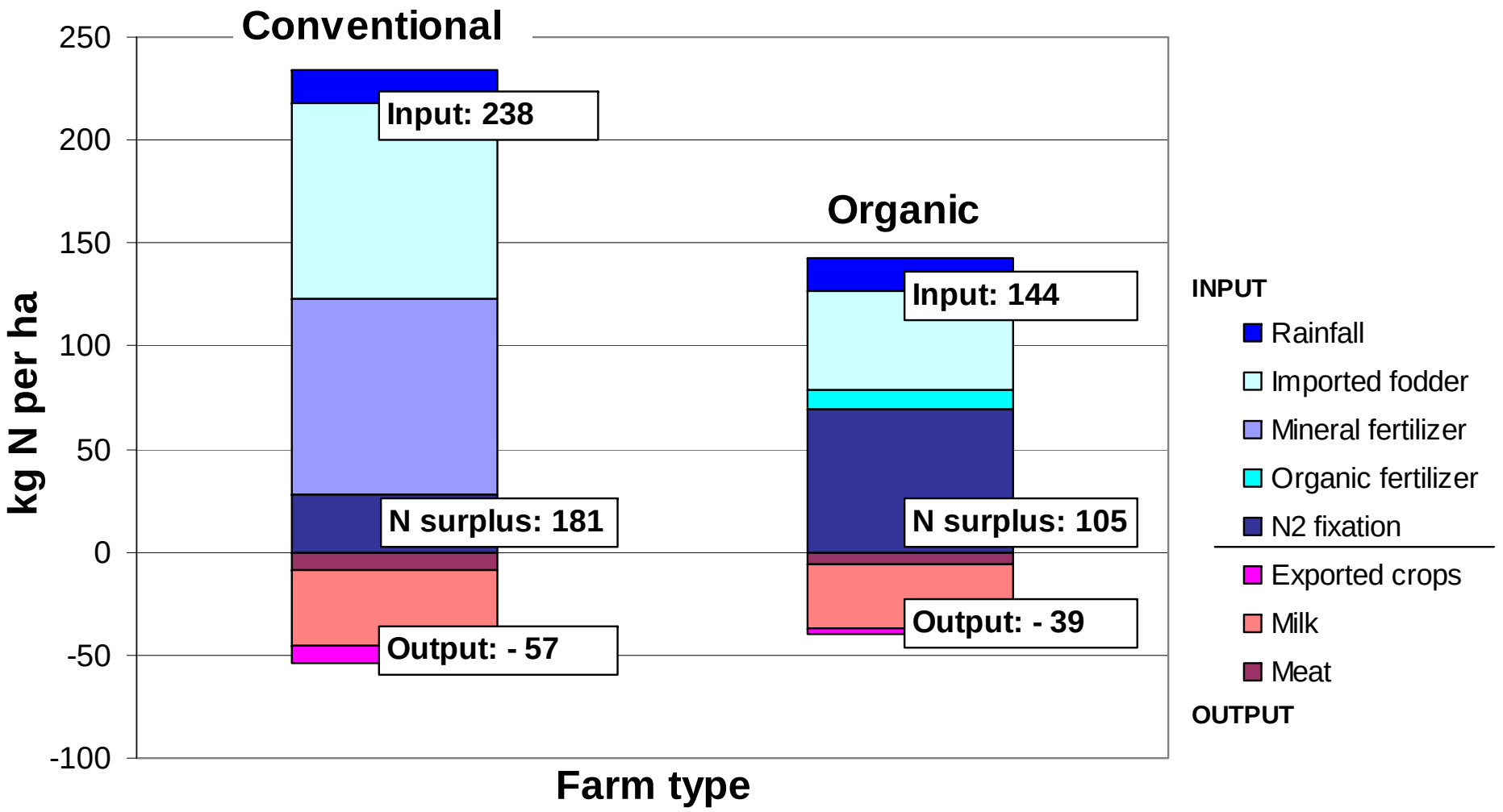
Characteristics of Danish dairy farms

	Average	
	Conventional	Organic
Number of cows per farm	61,3	81,9
Livestock units (DE)	99	128
Agricultural area, ha	68	100
Stocking rate, DE/ha	1,46	1,28
Cereal yield, hkg/ha,	51	41
Average yield, FE/ha	5700	4400
Milk production per cow, Kg milk/cow	7373	6855
Animal feed consumption, FU/DE	4764	4459

FØI-statistik, 1999
Kristensen et al., 2003

N surplus on dairy farms

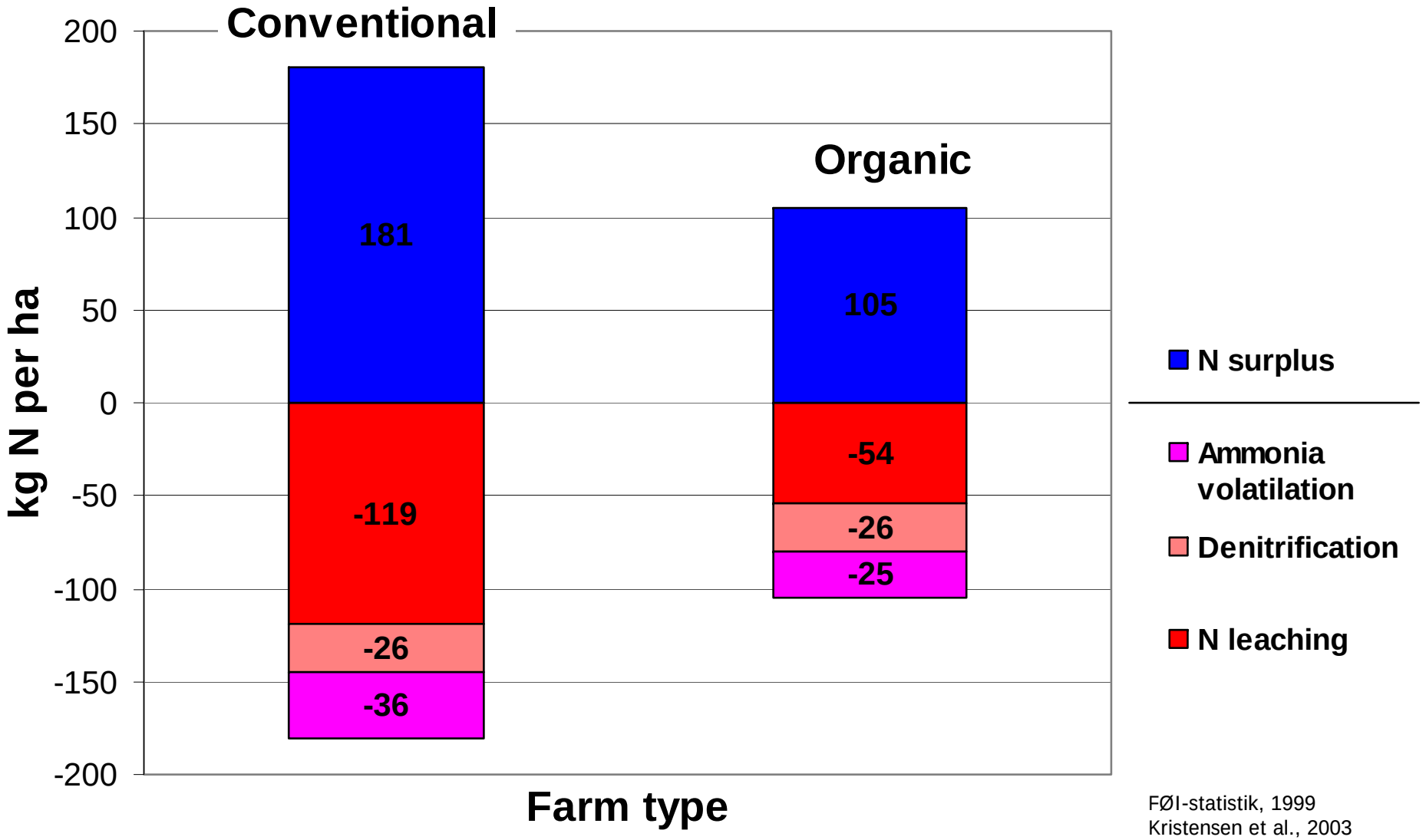
(kg N ha^{-1} $year^{-1}$)



FØI-statistik, 1999
Kristensen et al., 2003

N surplus and N loss on dairy farms

(kg N ha^{-1} $year^{-1}$)



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Kristensen et al., 2003

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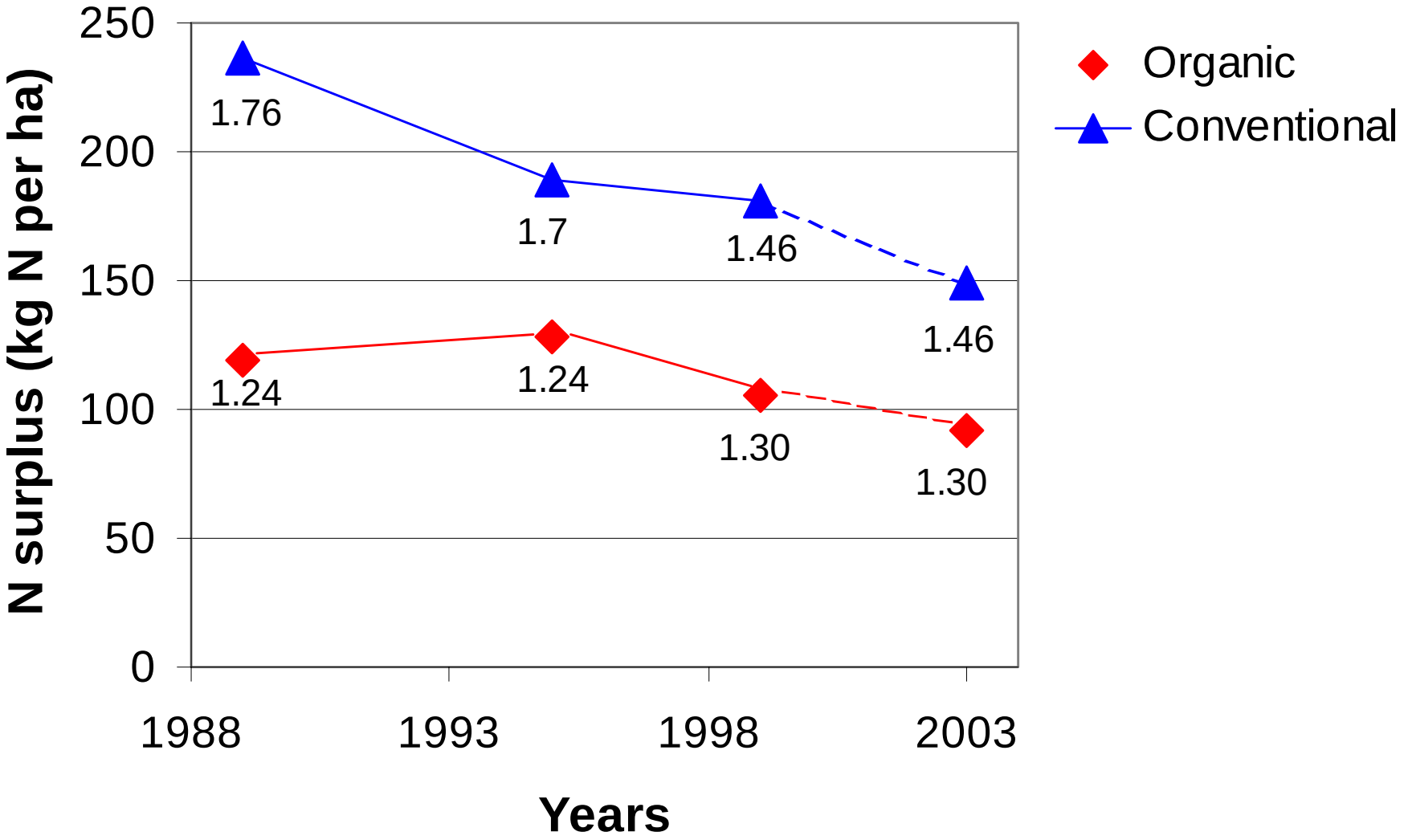
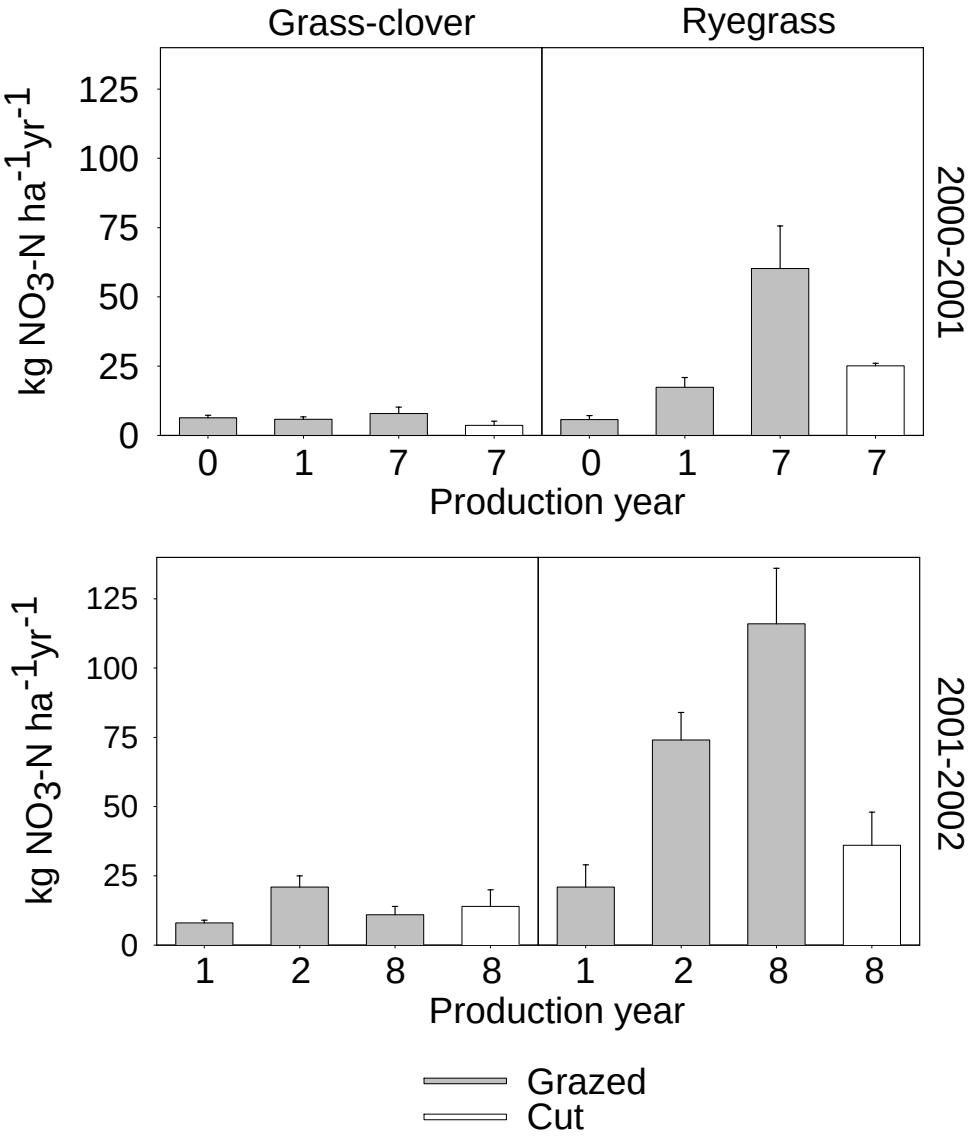


Note: The numbers below the symbols shows the stocking rate (animal units per ha) of the study.

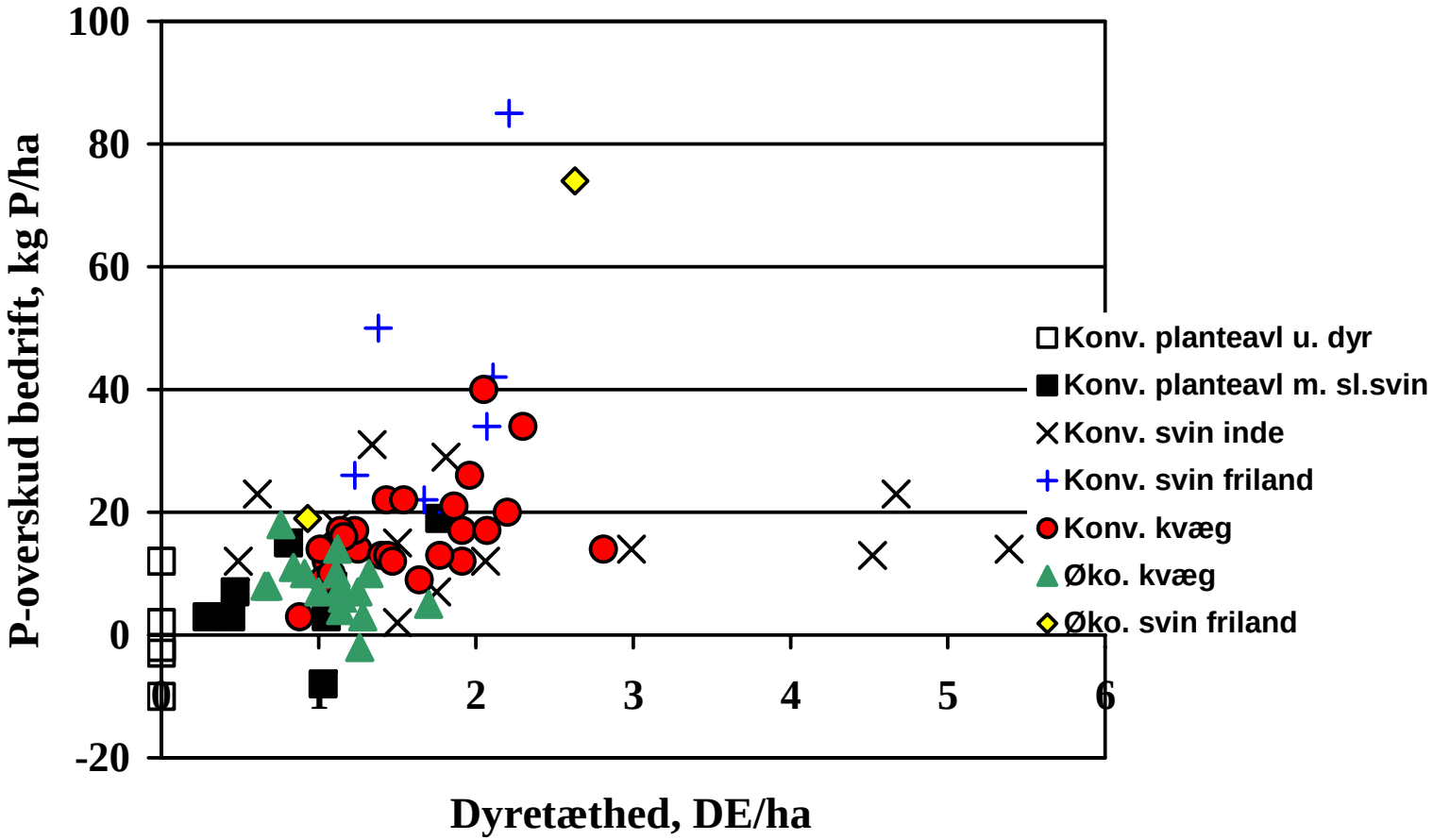
FØI-statistik, 1999
Kristensen et al., 2003

Nitrate leaching from grassland (Foulum) of different age, composition and management



P surplus of dairy farms

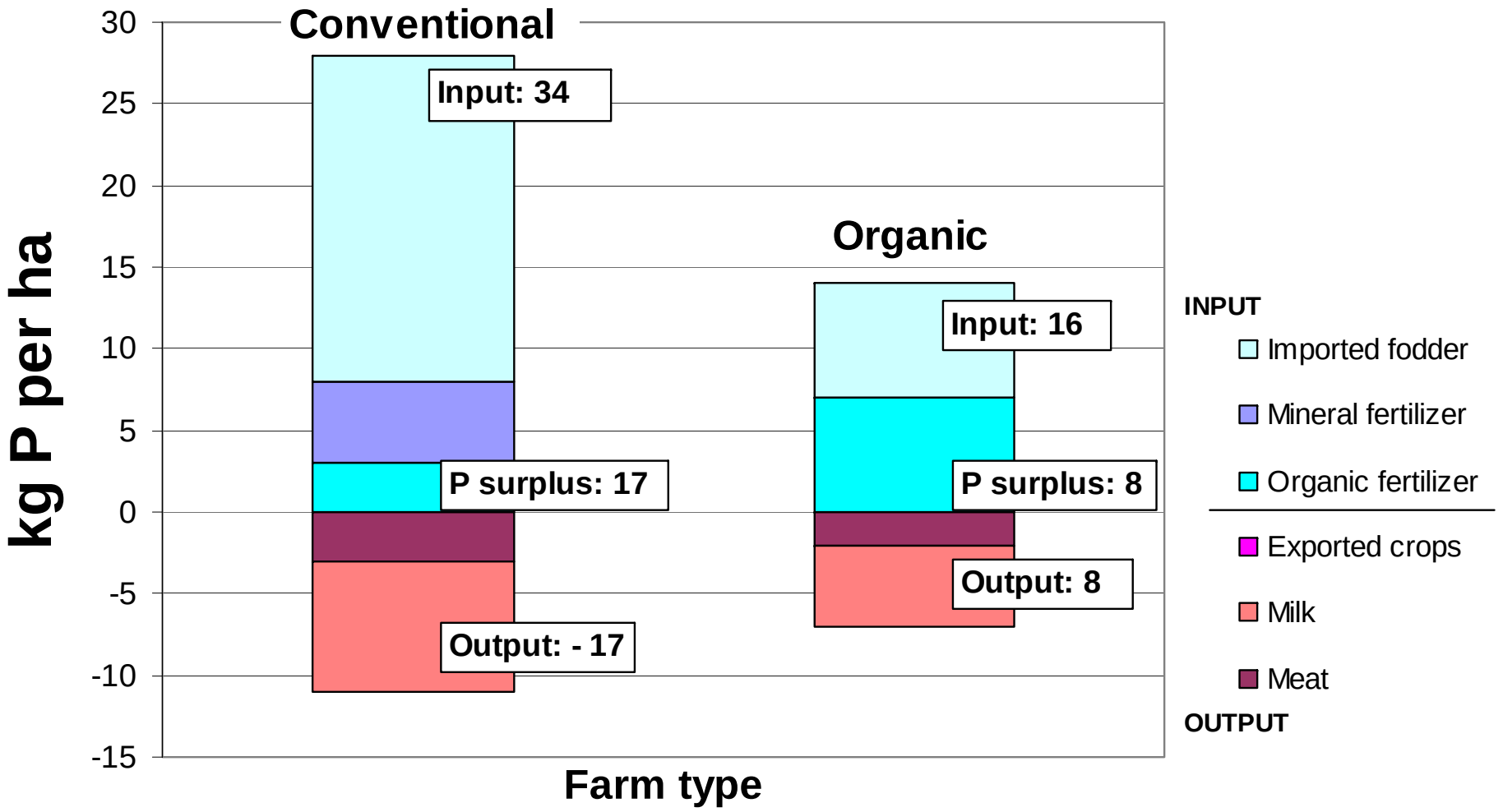
(Kg P ha^{-1} $year^{-1}$)



Studielandbrugene, 1997-2001
Halberg et al., 2003
http://www.vmp3.dk/Files/Filer/Rap_fra_t_grupper/VMP_III_Final_med_bilag.pdf

P surplus on dairy farms

(Kg P ha^{-1} $year^{-1}$)



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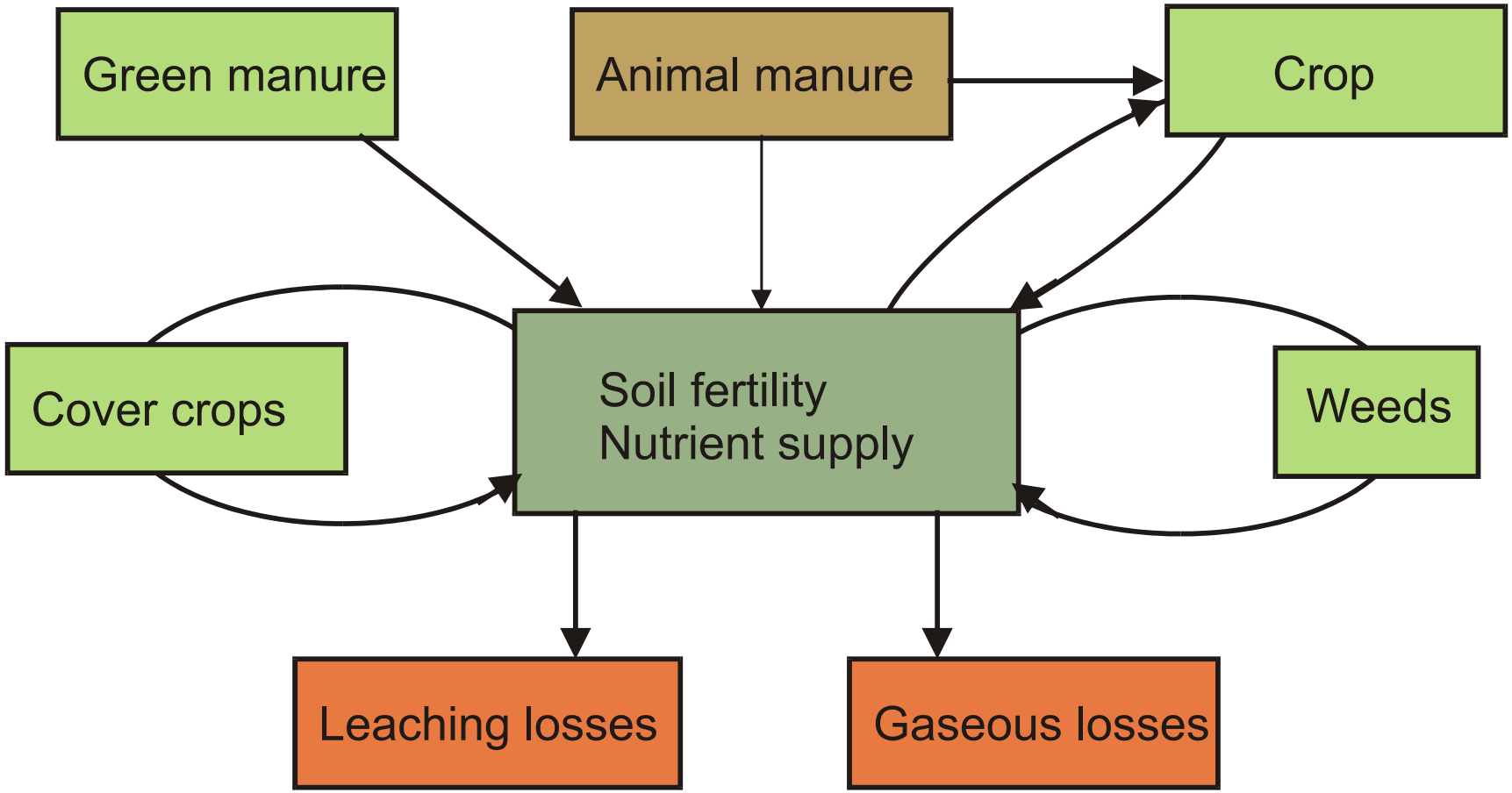
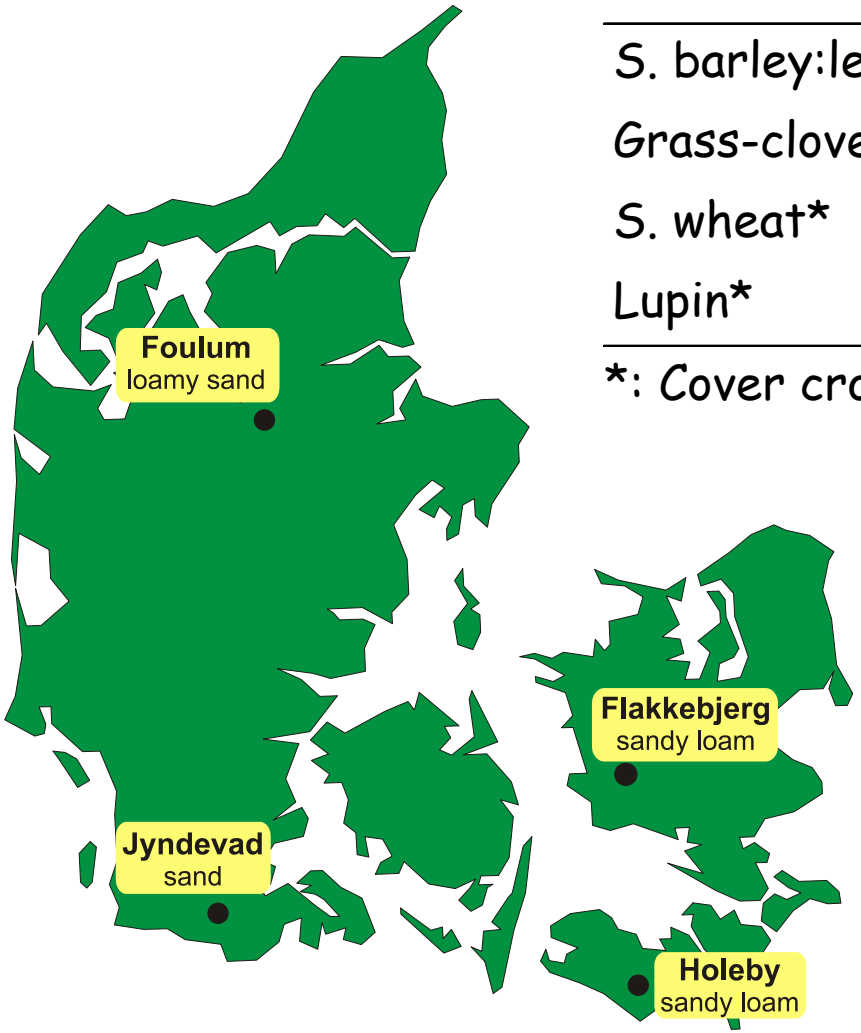
Nutrient dynamics



Crop rotation experiment



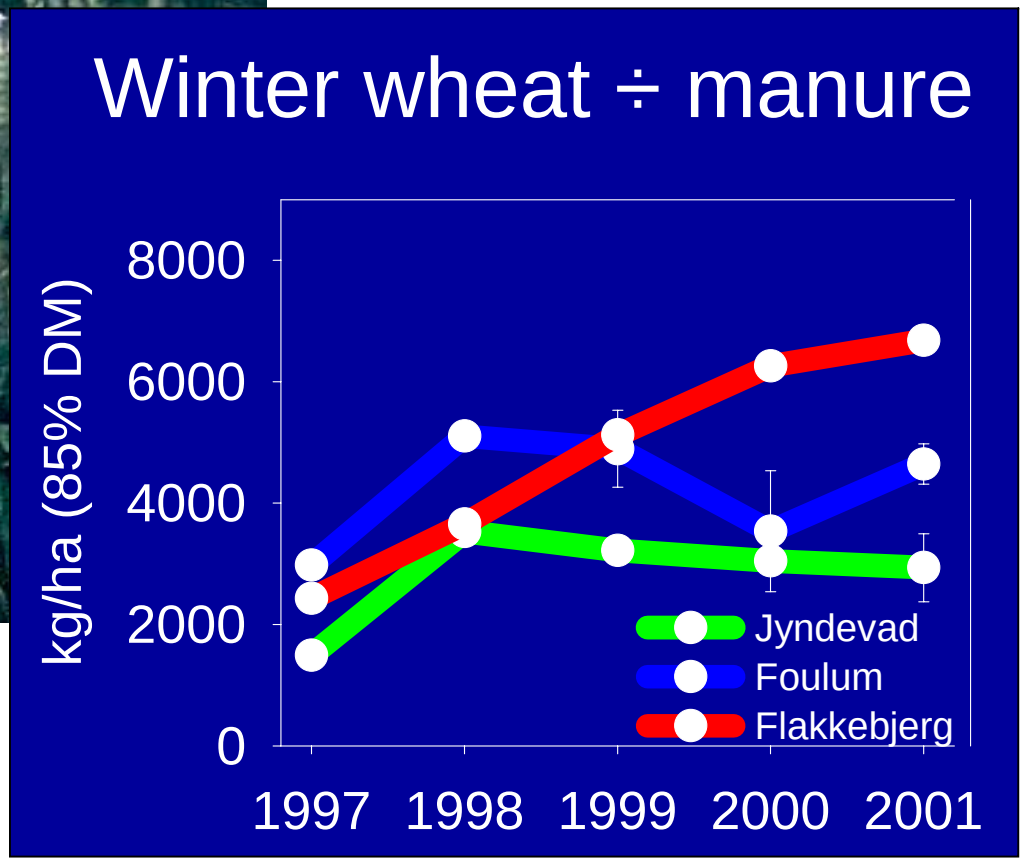
Rotation 1	Rotation 2	Sædskifte 4
S. barley:ley	S. barley:ley	S. oats*
Grass-clover	Grass-clover	W. wheat*
S. wheat*	W. wheat*	W. cereals*
Lupin*	Peas/barley*	Peas/barley*

*: Cover crops are used

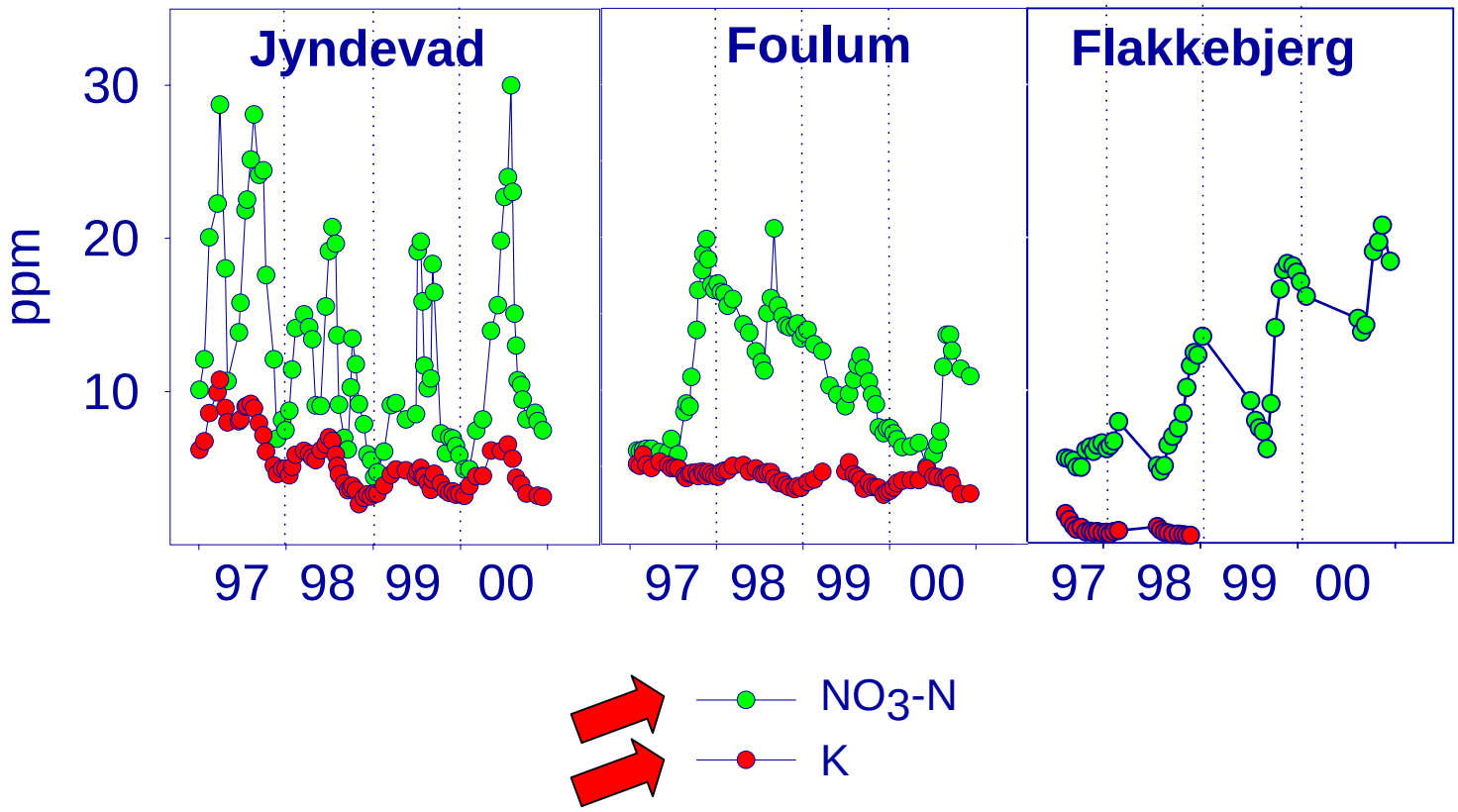
Experimental treatments:

- Crop rotation (proportion of cereals)
- +/- cover crop
- +/- animal manure (40% af norm)

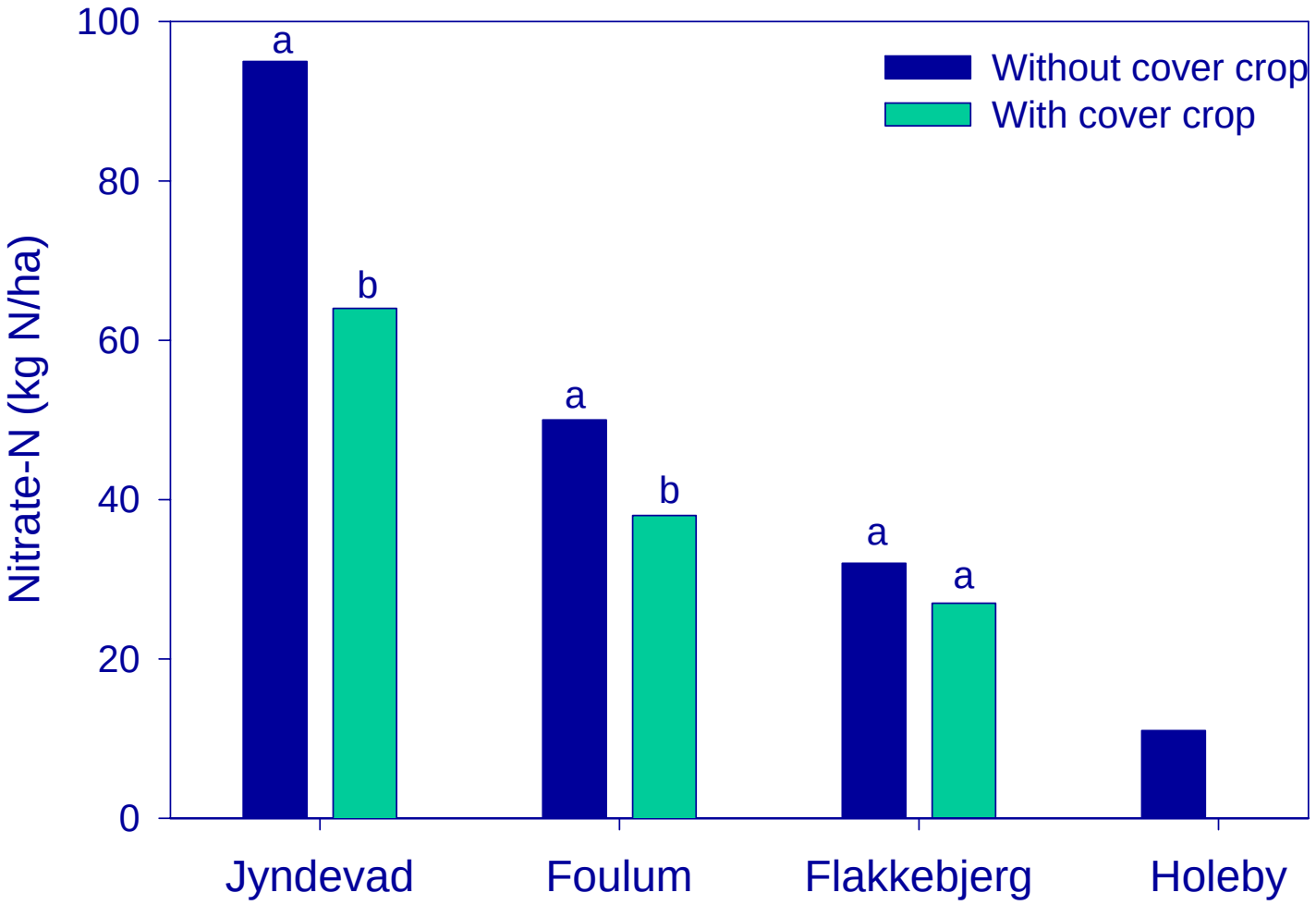
Grain yield in rotation 2



Concentrations of nitrate-N and K in soil water



N leaching in rotation 2



Model simulation of N balance on Danish arable farms

- Organic scenarios:
  - Basic: Crop rotation dominated by spring cereals with catch crops in 40% of crops and 20% clover/grass.
  - + catch crops: Catch crops (white clover/rye grass) in 70% of the crops.
  - 0 fertilisation: No manure is used.

- Conventional scenarios:
  - Basic: Crop rotation dominated by winter cereals and catch crops in 6% of the crops.
  - + catch crops: Catch crops (ryegrass) in 36% of the crops.

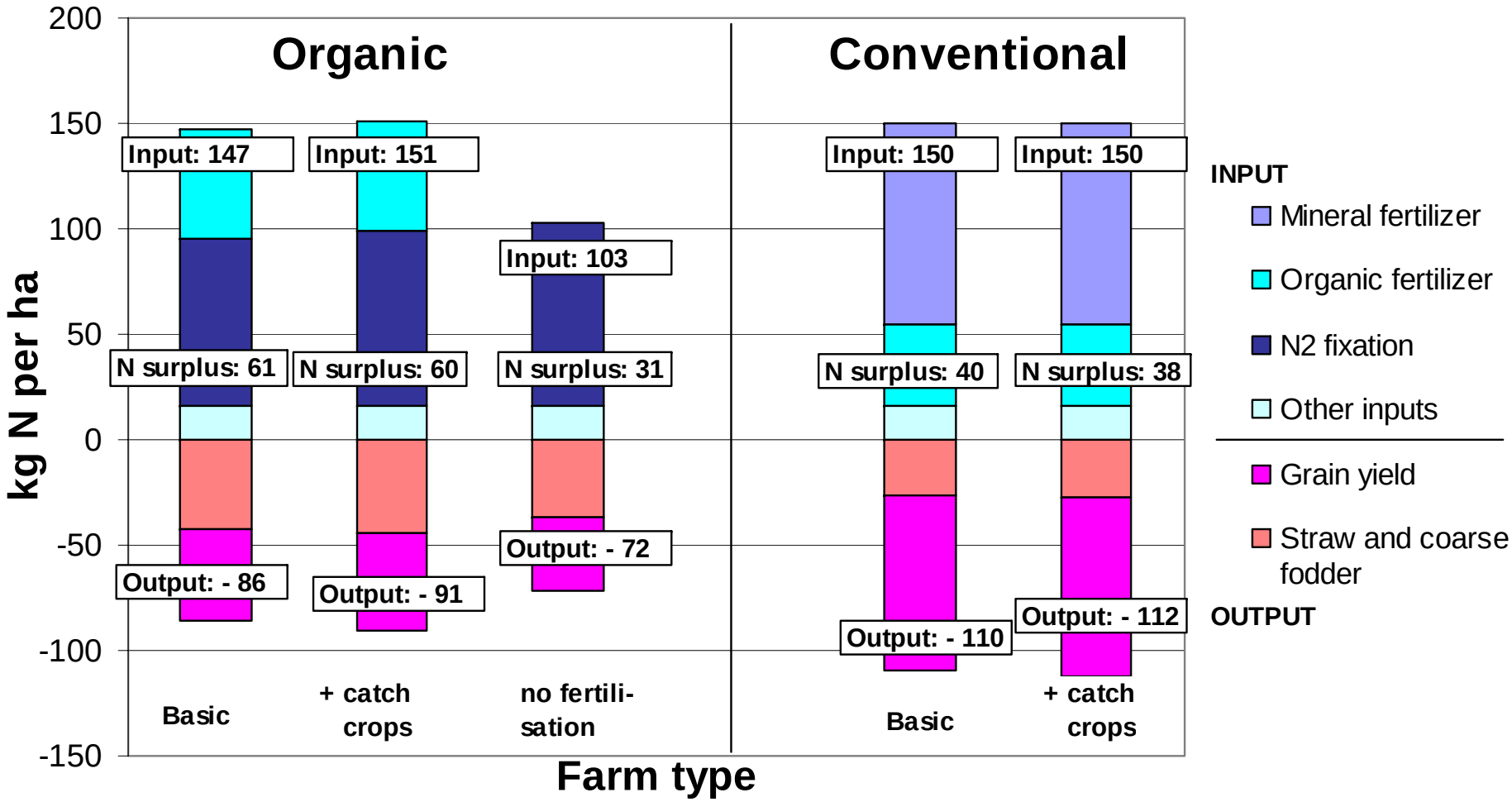
Note: Scenarios are representative for Danish agriculture.

Model simulation of N balance on Danish arable farms

- N balance at field level (incl. N leaching and changes in soil N organic matter) - calculated for scenarios using the FASSET model at:
    - Three soil types (Sandy soil, loamy sand and sandy loam)
    - Two levels of soil organic matter (high and low).

N surplus on arable farms

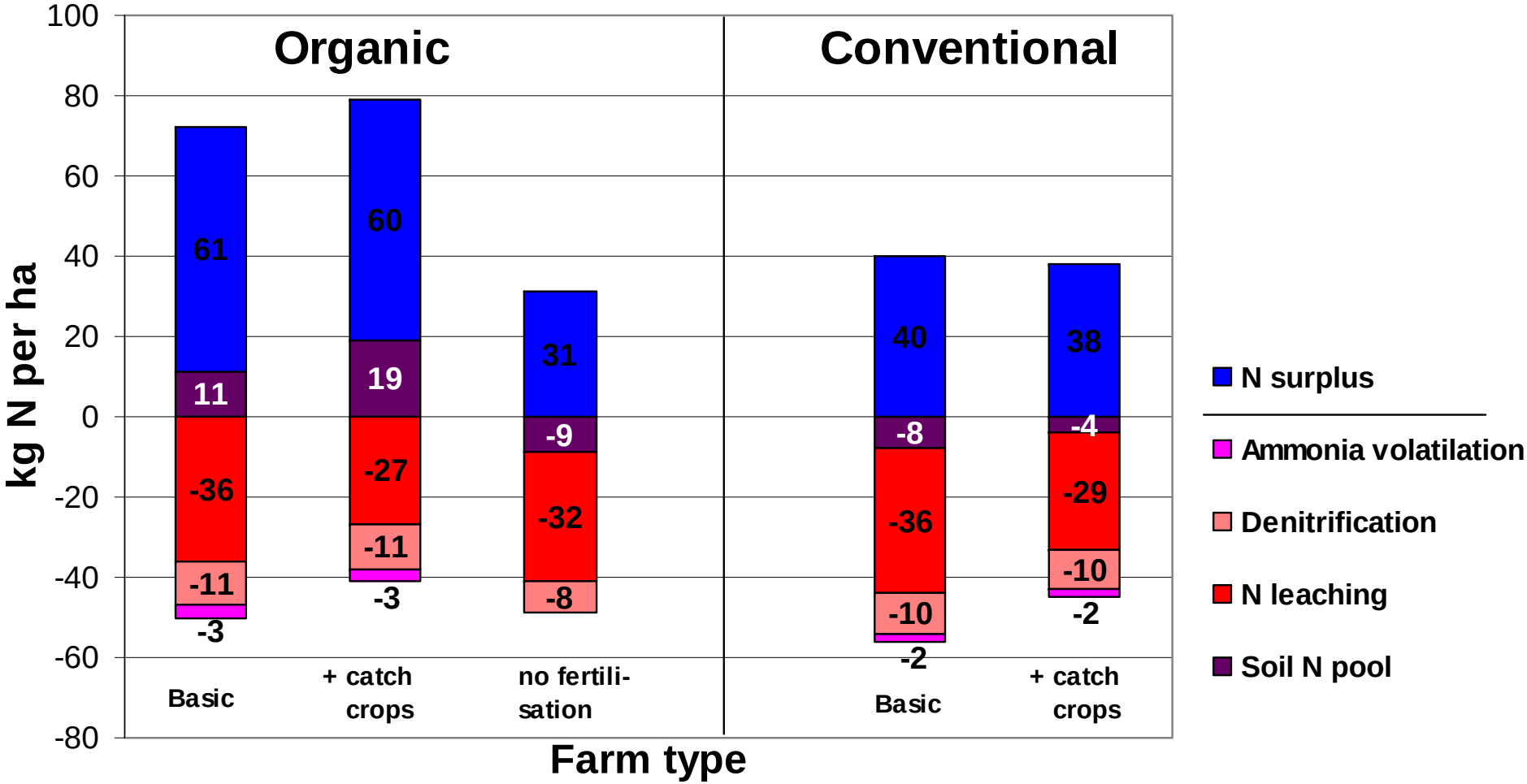
(kg N ha^{-1} $year^{-1}$)



Berntsen et al., 2004

N surplus and N loss on arable farms

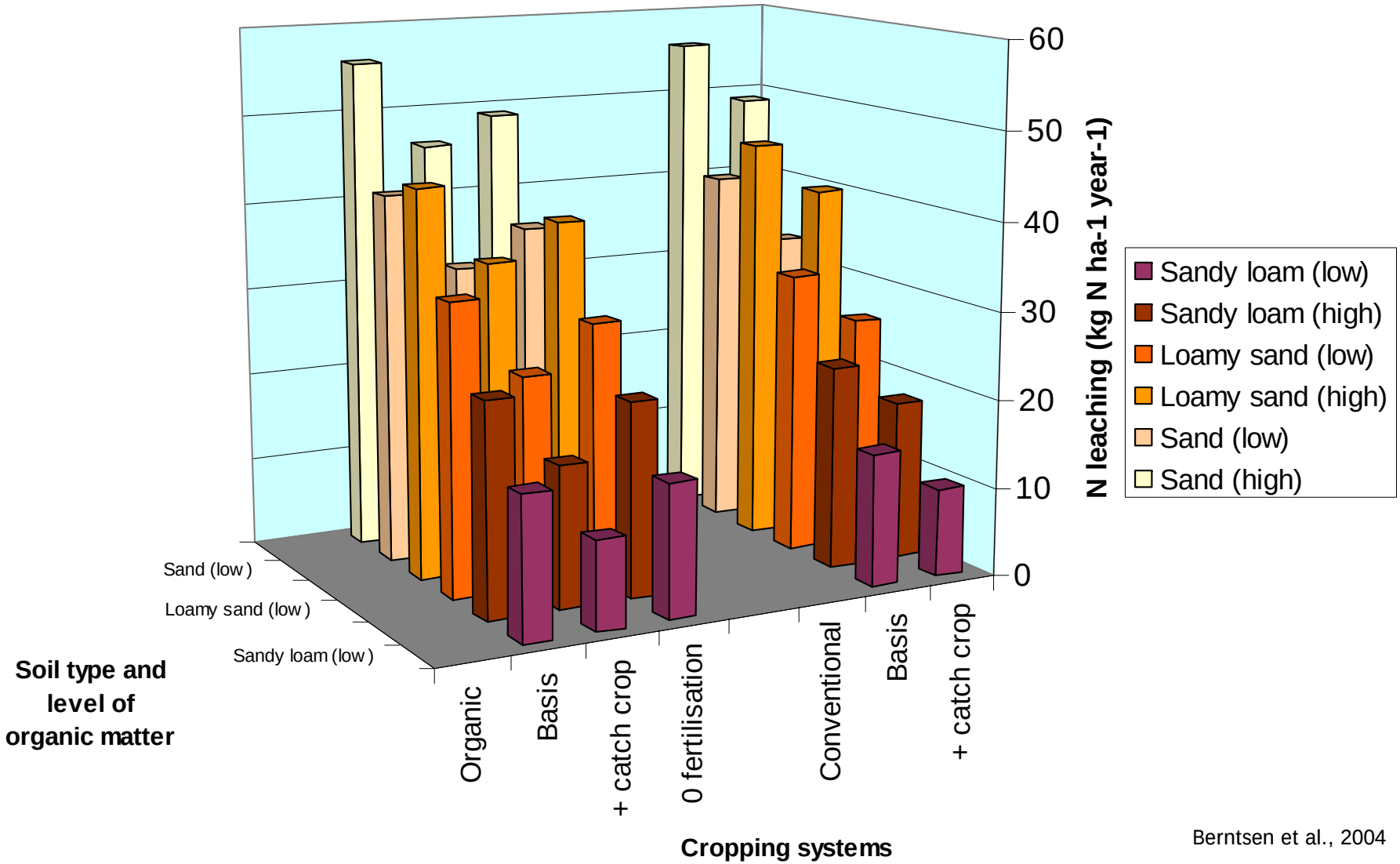
(kg N ha^{-1} $year^{-1}$)



Berntsen et al., 2004

N leaching on arable farms

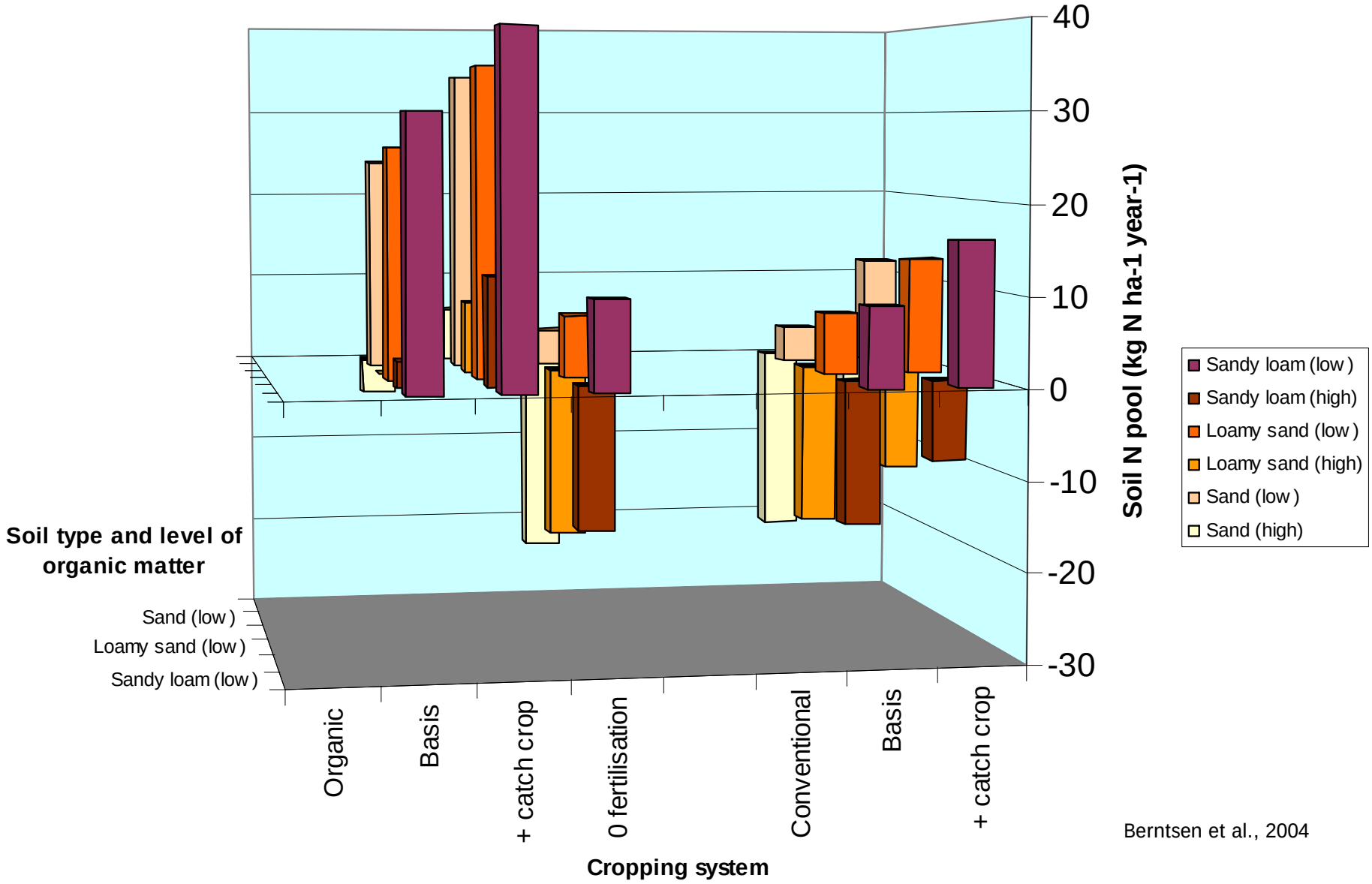
(kg N ha^{-1} $year^{-1}$)



Berntsen et al., 2004

Change in soil N pool on arable farms

(kg N ha^{-1} $year^{-1}$)



Berntsen et al., 2004

Conclusion

- Nitrate leaching from agriculture is a common problem for European aquatic environment
- Conversion to organic mixed/dairy farming decrease leaching of N because of decreased stocking rate and level of N-fertilizer
- Conversion to organic arable farming increase soil fertility, but has little effect on leaching of Nitrate at least at farm level and on a short term
- Organic farming has positive environmental benefits on the soil and the ecosystem

Assessment of environmental impact of organic farming

Table 9
A weighted assessment of the overall effect of organic farming on the environment relative to conventional farming achieved by synthesising the existing knowledge described[a]

	Category	Group of indicators	Effect	Major driving force
State of the environment	Aquatic environment	Pesticides leaching	++	Ban of pesticides
		Nitrate leaching	+/0	Crop rotation, nutrient use
		Phosphorous leaching	+/0	
	Soil	Organic matter	+/0	
		Biology	++	
		Structure	+/0	
	Ecosystem	Arable land	++/+	Crop rotation, ban of pesticides
		Semi-cultivated areas	+/0	Ban of pesticides, nutrient use
		Small biotopes	+/0	
		Landscape	+/0	Crop rotation, farm layout
Driving forces	Resource use and balance	Nitrogen	+/0/−	
		Phosphorus	+/0	
		Potassium	+/0	
		Energy use	++/+	

[a] (++) much better; (+) better; (0) the same; (−) worse.

Source: Hansen et al. (2001)