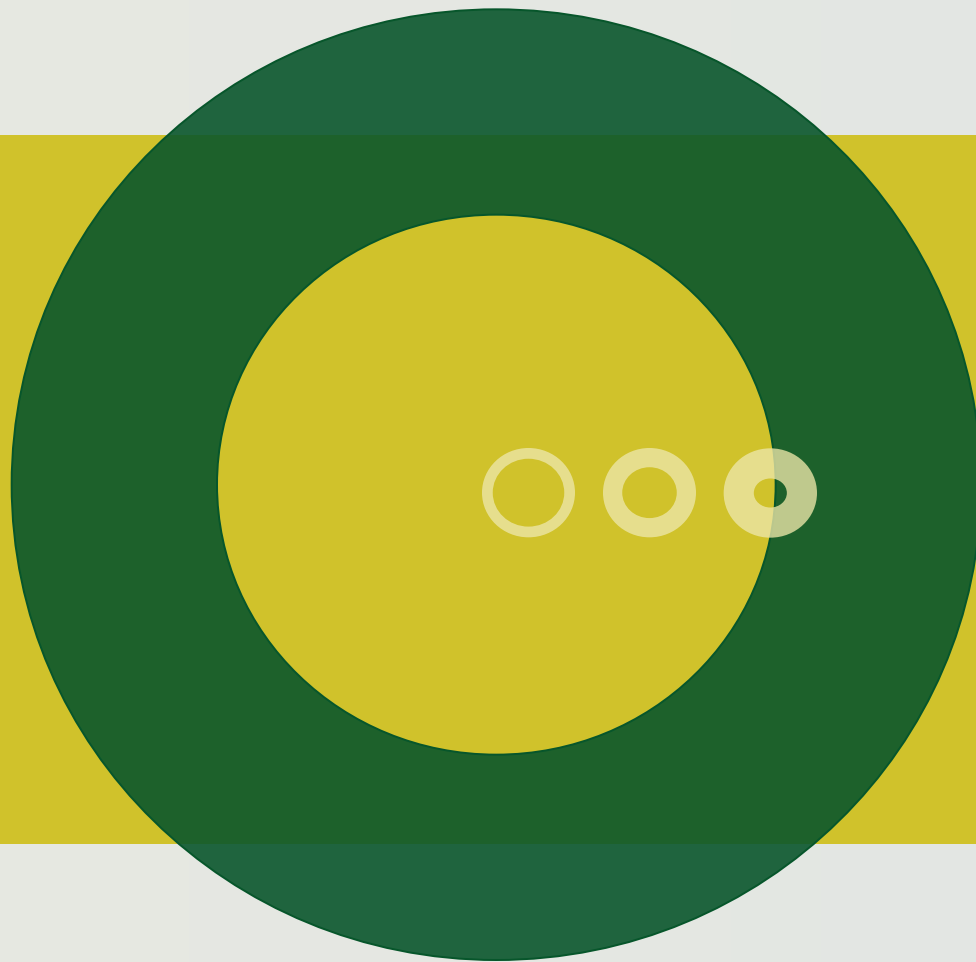


# Best Agriculture in Practice. Denmark (Nutrient management)

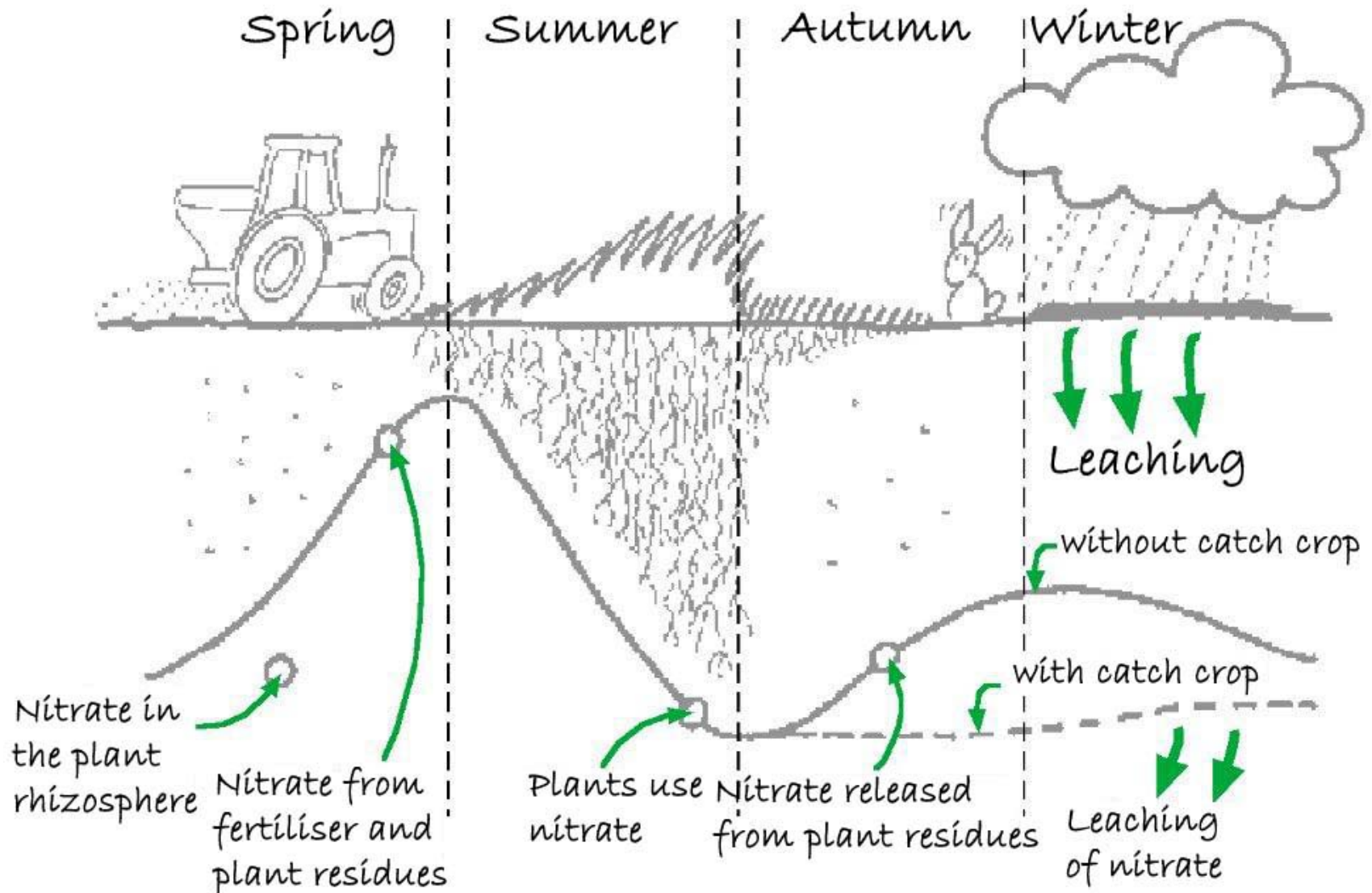
Chief adviser  
Carl Aage Pedersen.

Yara conference:  
A cleaner Baltic Sea..

Kaschow, June 2014



Best practice for Nitrogen management:  
Apply Nitrogen when needed by the crops and avoid  
accumulation of Nitrate in leaching periods.



# Danish Agricultural Advisory Service - DAAS



- Partnership
- 30 local centres and Knowledge Centre for Agriculture
- 3,500 employees
- approx. EUR 242 mill.
- From 1.25 to 550 employees



# Large livestock production!



We produce 21 mill. pigs per year  
approx. 800,000 sows

- 5 pigs per Dane per year



Danmark has ½ mill. milking cows

- 2.5 l milk per Dane per day



60% of Denmark's land area is  
cultivated – 2,624,000 hectares

In 1986, oxygen depletion hit large areas in the southern part of Kattegat and large quantities of lobsters died.

It was the beginning of a wide range of environmental regulations in Denmark

Urban waste water or agriculture ?



Already in 1983,  
the Danish  
Farmers' Union  
asked for/  
demanded  
intensive advice  
on how to  
enhance the  
utilization of  
animal manure

## DE DANSKE LANDBOFORENINGER

Landskontoret for Planteavl  
Hr. Frank Bennetzen  
Kongsgårdsvej 28  
8260 Viby J.

AXELBORG, 4. sal  
VESTERBROGADE 4 A  
1620 KØBENHAVN V  
POSTGIRO: 5 40 27 43  
TELE: 01-12 75 61  
Den 13. juli 1983.  
KØ/da

Kære Frank Bennetzen,

Jeg har forstået på Ib Skovgaard, at der er en smule tvivl om i hvilket omfang, der her fra De danske Landboforeninger er ønsket om en intensiveret rådgivningsindsats vedrørende hele staldgødningsproblemet.

For at rydde denne tvivl til side sender jeg vedlagt formandskabets meddelelser til bestyrelsesmødet den 18. maj. På side 2 i meddelelserne har formandskabet søgt og fået bestyrelsens tilslutning til at bede landsudvalget for planteavl om at tage denne rådgivningssag op.

Jeg beklager, hvis vi har forsømt at give jer besked herom, men dette er forhåbentlig hermed rådet bod på.

Med venlig hilsen

# Utilization of animal manure in Danish Agriculture

## - 3 periods:

- Until 1980: Bad manure management.  
Nitrogen utilization below 20 per cent.
- 1985-1999: Enormous improvements  
Utilization rose to 70 per cent
- After 2000: Starving crops



# Action Plan for Better utilization of Animal Manure

- Danish Farmers' Union 1987





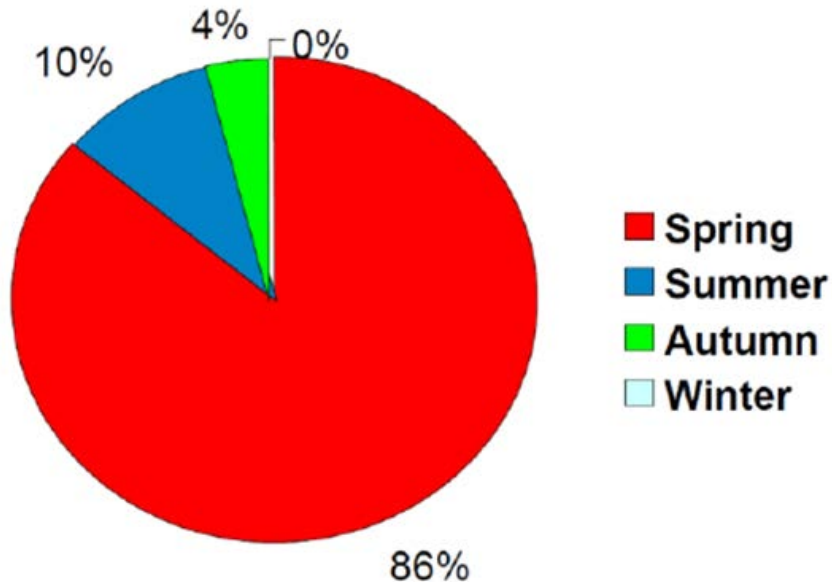
Year	Action plan/legislation	Main instruments
1985	NPO – Nitrogen, Phosphorus and organic matter	Maximum livestock per hectare No direct outlets of manure
1987	Water environmental protection <b>plan I</b>	<b>Mandatory fertilizer plans</b> Demands for storage capacity of slurry, “wintergreen fields”
1992	Sustainable agriculture	Max quotas for nitrogen <b>Minimum utilization of N in manure</b> Restriction for slurry application in autumn.
1998	Water environmental protection <b>plan II</b>	Reduced N-quotas to 10 per cent below optimal rates. Demands to catch crops Establishing “wetlands”
2003	Water environmental protection <b>plan III</b>	Extended demands for catch crops Extended demands for utilization of manure
2009	“Green Growth”	Extended demands for catch crops Specific regulation of vulnerable areas No tillage in autumn before spring sown crops (New N regulation system based on tradable N quotas – a suggestion)

# Restrictions in application times

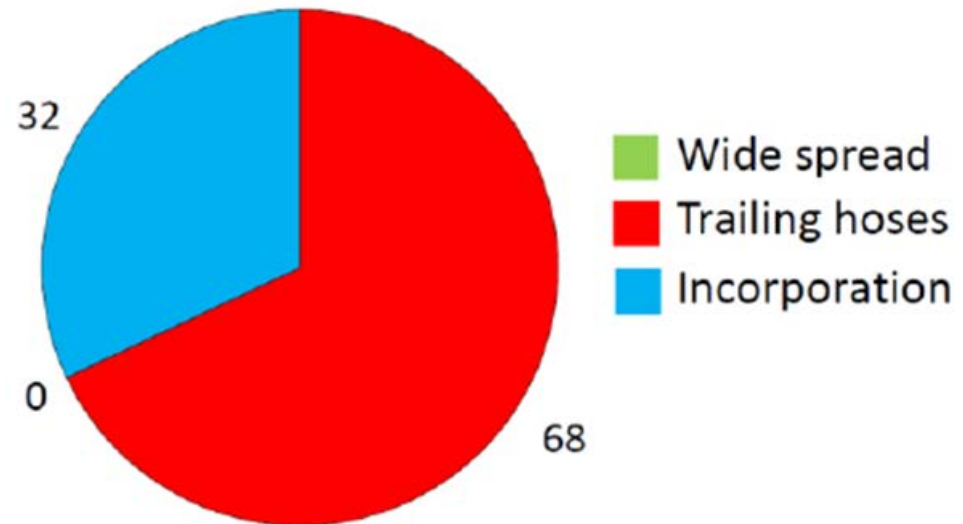
Type	Restrictions	Technique
Liquid manure	No application from harvest to 1 <sup>st</sup> of February. Except: from harvest to 1 <sup>st</sup> of October to winter oilseed rape and grass From harvest until 15 <sup>th</sup> of October to grass for seed	From 2011 direct injection on bare soils and grass. Only in winter cereals trailing hoses are OK
Solid manure	Without crop in winter: Banned from harvest until 1 <sup>st</sup> of November	Incorporation on bare soils within 6 hours

# Slurry is gold

## Application of slurry



## Spread of slurry



# Trailing hoses



## Injection

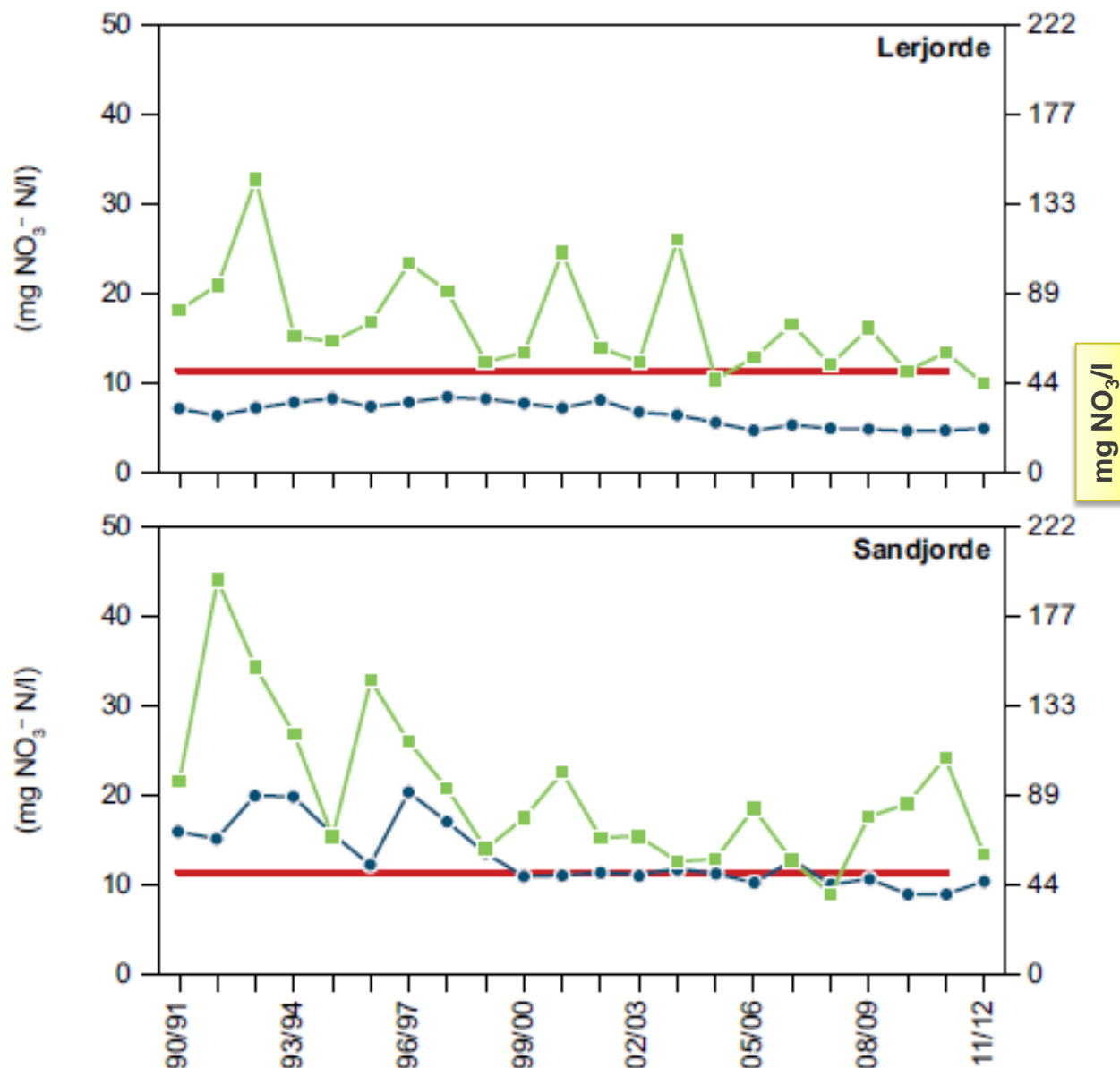


## **Result:**

**The nitrogen leaching is reduced by more than 50 per cent.**

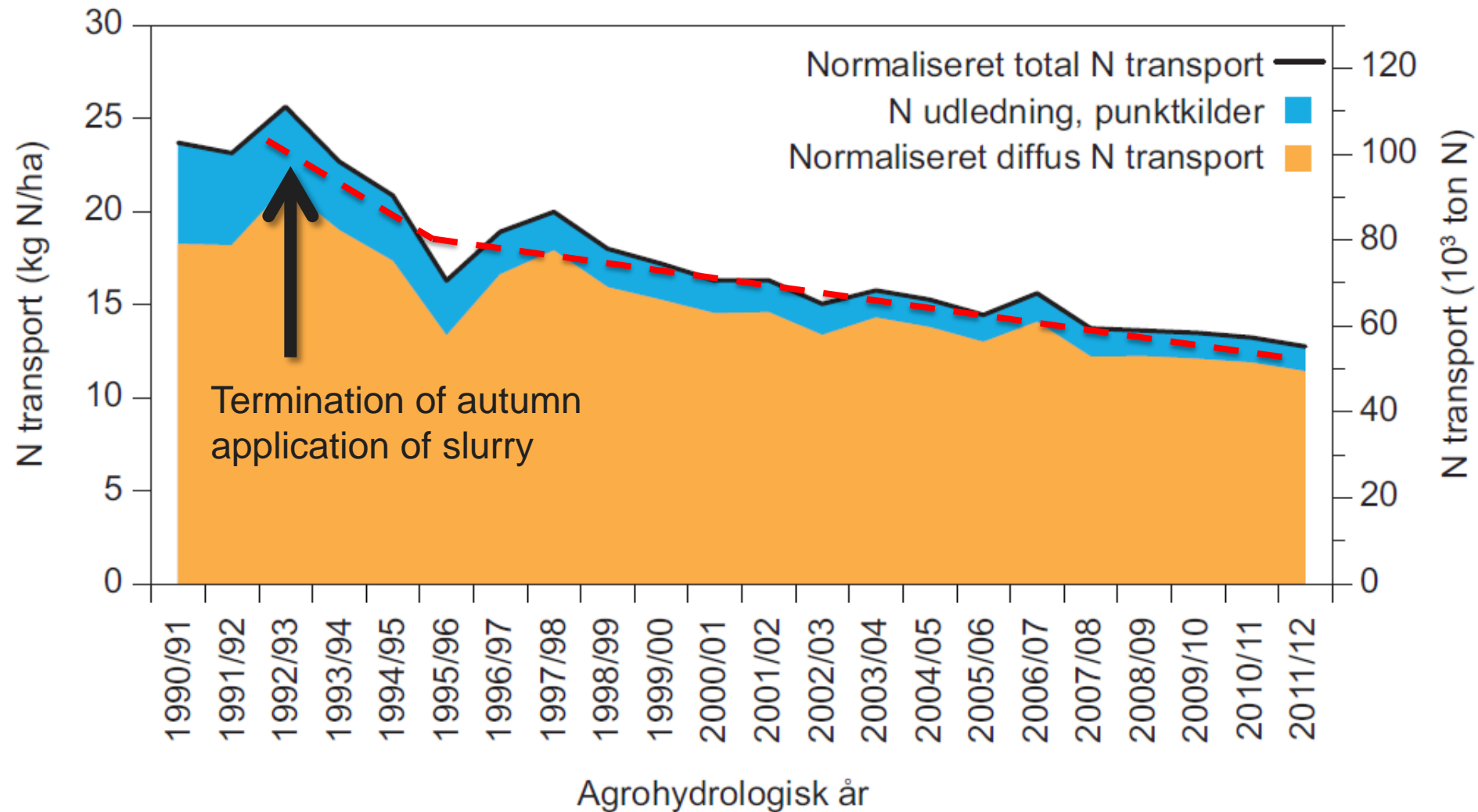
Nitrogen concentration  
in root zone water  
(green)  
and the upper (0 – 5 m)  
groundwater (blue)

Source:  
Landovervå-  
ningsoplande  
2012, DCE 2013

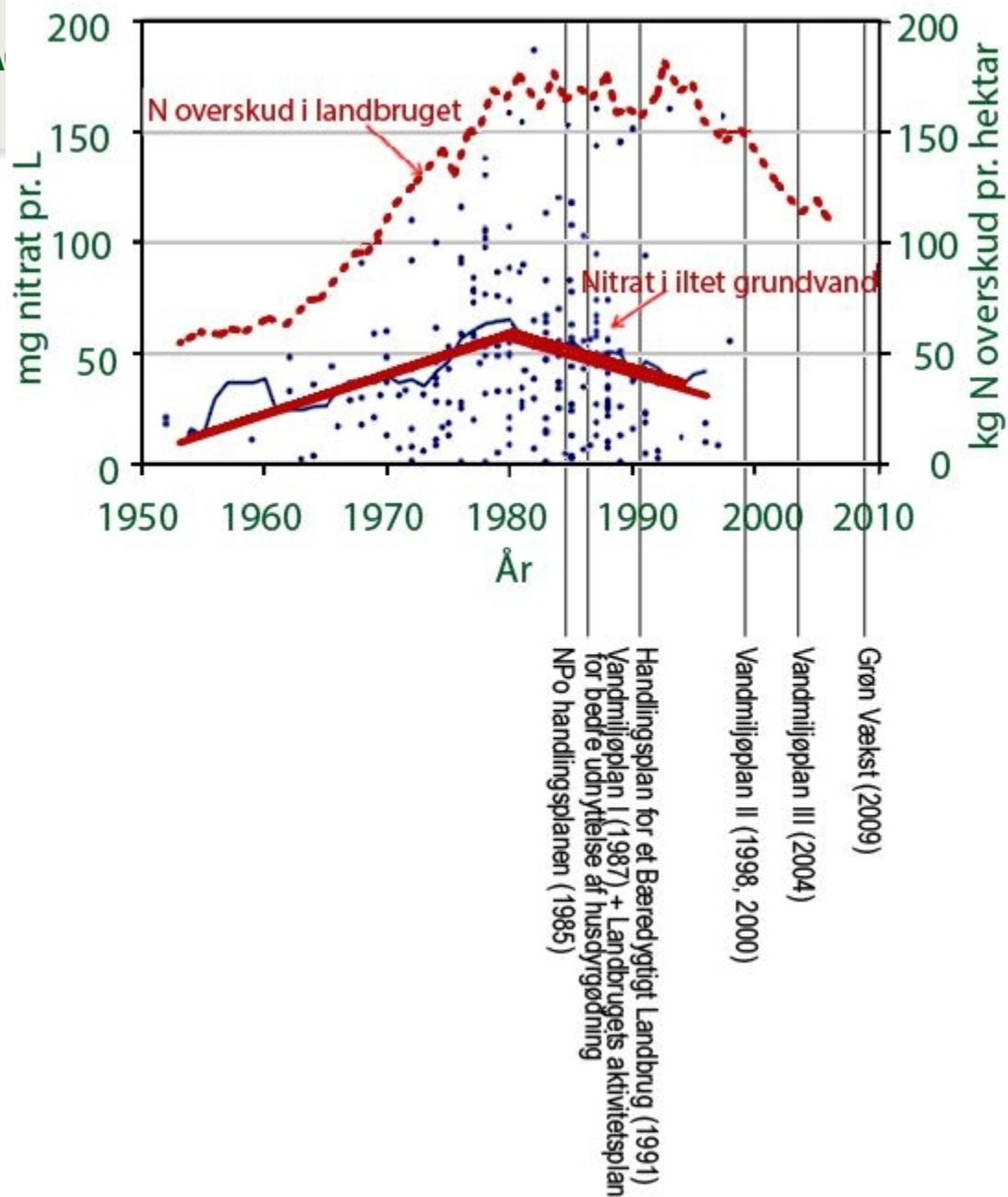




# Loss of Nitrogen to coastal waters



## Decreasing nitrate content in the ground water since 1980



**Table 1: Normer for landbrugsafgrøder og grønsager på friland (kvælstof, fosfor og kalium)**

Kvælstofnormer og retningsgivende normer for fosfor og kalium i kg pr. ha for 2012/2013																			
Normerne angiver total mængde kvælstof på årsbasis. For grønsager på friland, hvor der er fastsat en artsspecifik kvælstofnorm, gælder normen pr. kultur.																			
Afgrødekod	Afgrøde	Forfrøgtværdi	Kvælstofnorm	Uvandet grovssæd JB 1 + 3		Uvandet finsæd JB 2 + 4 og 10-12 <sup>1</sup>		Vandet sandjord JB 1 - 4		Sandblandet lerjord JB 5 - 6		Lerjord JB 7 - 9		Korrektion for udbytte	Retningsgivende normer for fosfor og kalium <sup>15</sup>				
				kg N/ha	Ja/Nej	Udbytte-norm kg/ha	Kvælstof-norm kg N/ha	Udbytte-norm kg/ha	Kvælstof-norm kg N/ha	Udbytte-norm kg/ha	Kvælstof-norm kg N/ha	Udbytte-norm kg/ha	Kvælstof-norm kg N/ha		Udbytte-norm kg/ha	Kvælstof-norm kg N/ha	kg N/ha	kg P/ha	kg K/ha
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Vårsæd til modenhed																			
1	Vårbyg <sup>2</sup>	0	Ja	37 (41)	108	44 (48)	103	49 (54)	123	56 (62)	110	60 (66)	124	1,5	22	43			
2	Vårhvede <sup>2</sup>	0	Ja	34 (37)	110	40 (44)	104	45 (50)	122	51 (56)	108	55 (61)	121	1,3	19	40			
6	Vårhvede, brødhvede <sup>2</sup>	0	Ja	34 (37)	162	40 (44)	158	45 (50)	181	51 (56)	166	55 (61)	183	1,7	19	40			
3	Havre	0	Ja	39	88	46	84	51	103	52	84	55	96	1,5	25	51			
4	Andre kornarter, vårsæt	0	Ja	40	90	47	85	52	105	52	84	56	97	1,5	23	45			
50	Anden brødblade afgrøde	23	Ja	29	117	37	108	37	123	42	103	44	113	1,5	38	58			
5	Majs til modenhed	0	Ja	66	149	66	136	73	162	72	139	76	164	1,5	38	58			
7	Korn + bælgssæd under 50 % bælgssæd	8	Ja	39	65	42	53	45	68	48	47	50	57	0,5	23	49			
Vintersæd til modenhed																			
10	Vinterbyg <sup>2</sup>	0	Ja	48 (53)	146	52 (57)	137	56 (62)	154	71 (78)	148	76 (84)	162	1,2	20	51			
11	Vinterhvede <sup>2</sup>	0	Ja	49 (54)	144	63 (69)	146	67 (74)	164	81 (89)	159	86 (95)	172	1,3	22	72			
13	Vinterhvede, brødhvede <sup>2</sup>	0	Ja	49 (54)	208	63 (69)	217	67 (74)	239	81 (89)	238	86 (95)	256	1,7	22	72			
14	Vinterrug <sup>2</sup>	0	Ja	40 (44)	112	53 (58)	113	52 (57)	124	65 (72)	116	69 (76)	129	1,2	18	55			
15	Hybridrug <sup>2</sup>	0	Ja	50 (55)	123	65 (72)	126	65 (72)	139	76 (84)	128	81 (89)	142	1,2	22	67			
16	Triticale <sup>2</sup>	0	Ja	41 (45)	140	53 (58)	139	53 (58)	152	61 (67)	139	65 (72)	151	1,2	22	59			
17	Andre kornarter, efterårsset <sup>2</sup>	0	Ja	39 (43)	112	51 (56)	111	48 (53)	121	61 (67)	113	65 (72)	126	1,2	22	58			
Oliefro og bælgssæd																			
21	Vårrops	19	Ja	19	119	22	109	24	125	25	105								
22	Vinterraps	19	Ja	27	177	35	188	35	188	40	194								
23	Rybs	19	Ja	18	117	20	107	22	122	23	102								
24	Solsikke	19	Ja	18	159	20	146	22	159	23	138								
25	Sojabønner	19	Nej	45	0	45	0	45	0	45	0								
180	Gul sennep	19	Ja	19	118	21	108	23	123	23	102								
181	Anden oliefroart	19	Ja	19	118	21	108	22	123	23	102								
30	Ærter	15	Nej	45	0	45	0	45	0	45	0								
														Slagtesvin, 1 stk. produceret, 75 kg nilvægt					
														32 kg til 107 kg levende vægt =					
														(32 kg til 82 kg slagtevægt)					
														(levende vægt = 1,31* slagtevægt)					
Svovlsæd - 2 ha																			

Slagtevvin, 1 stk. produceret, 75 kg tilvækst  
 (32 kg til 107 kg levende vægt = 32 kg til 82 kg slagtevægt)  
 (levende vægt = 1,31 \* slagtevægt)

Forudsætninger:  
 Tilvækst 75 kg  
 FE<sub>u</sub> pr. kg tilvækst 2,84 FE<sub>u</sub>  
 Råprotein pr. FE<sub>u</sub> 148,0 g  
 Fosfor pr. FE<sub>u</sub> 4,6 g

Ab dyr, udskilt i alt:  
 Mængde 0,47 ton  
 N 2,82 kg (0,96+1,87)  
 P 0,57 kg  
 K 1,33 kg

Mængden af lager		Ton godning	pct.	Indhold i alt				Indhold pr. ton godning				Emission Kg N (ammonisk)
				Kg N	Kg NH <sub>4</sub> -N	Kg P	Kg K	Kg N	Kg NH <sub>4</sub> -N	Kg P	Kg K	
Delvis spaltegulv med 50-75% fast gulv	Gylle	0,48	6,6	2,54	1,91	0,57	1,33	5,34	4,01	1,19	2,79	0,28 (0,24+0,04)
Delvis spaltegulv med 25-49% fast gulv	Gylle	0,48	6,6	2,47	1,85	0,57	1,33	5,19	3,89	1,19	2,79	0,36 (0,32+0,04)
Fuldspaltegulv	Gylle	0,51	6,1	2,34	1,76	0,57	1,33	4,55	3,41	1,10	2,58	0,48 (0,45+0,04)
Drænet gulv + spalter (33/67)	Gylle	0,51	6,1	2,40	1,80	0,57	1,33	4,65	3,49	1,10	2,58	0,43 (0,39+0,04)
Fast gulv	Staldgodning	0,10	23,0	1,08	0,38	0,51	0,87	11,00	3,85	5,22	8,85	0,73 (0,50+0,23)
	lejeareal	0,33	2,0	0,92	0,82	0,06	0,62	2,76	2,48	0,18	1,86	
Dybstroelse, opdelt	Dybstroelse	0,09	33,0	0,95	0,24	0,30	1,10	11,16	2,79	3,55	12,88	
	Gylle	0,32	4,9	1,22	0,92	0,28	0,66	3,82	2,87	0,89	2,07	0,52 (0,38+0,14)
Dybstroelse	Dybstroelse	0,17	33,0	1,91	0,48	0,61	2,20	11,16	2,79	3,55	12,88	0,66 (0,42+0,24)

Korrektion for afvigende vægtinterval:  
 Der korrigeres med følgende faktor:  
 for kvælstof: (slutvægt – startvægt) x (12,77 + 0,1789 x (slutvægt + startvægt)) / 2824  
 for fosfor: (slutvægt – startvægt) x (4,59 + 0,0214 x (slutvægt + startvægt)) / 567  
 Korrektion af kvælstofmængde ved afvigende fodermængde og -sammensætning:  
 Der korrigeres med følgende faktor:  
 ((kg foder pr. produceret gris x kg N pr. kg foder) - ((afgangsvægt - indgangsvægt) x 0,0296 kg N pr. kg tilvækst)) / 2,824  
 eller ((FE<sub>u</sub> pr. produceret svin x g råprotein pr. FE<sub>u</sub> / 6250) - ((afgangsvægt - indgangsvægt) x 0,0296 kg N pr. kg tilvækst)) / 2,824  
 Korrektion af fosformængde ved afvigende fodermængde og -sammensætning:  
 Der korrigeres med følgende faktor:  
 ((kg foder pr. produceret gris x kg P pr. kg foder) - ((afgangsvægt - indgangsvægt) x 0,0055 kg P pr. kg tilvækst)) / 0,567  
 eller ((FE<sub>u</sub> pr. produceret svin x g fosfor pr. FE<sub>u</sub> / 1000) - ((afgangsvægt - indgangsvægt) x 0,0055 kg P pr. kg tilvækst)) / 0,567

Rules for fertilization and use of animal manure – 149 pages

<http://1.naturerhverv.fvm.dk/goedningsregnskab.aspx?ID=2268>

Manure standards for all kinds of livestock

# Utilization rate

- *of total-nitrogen content in manure*

An example of winter wheat:

Nitrogen requirement/ha:

150 kg N/ha

÷ 25 tons of pig slurry by 5.4 kg total nitrogen/ton and an expected effect on the field of 65% (25x5.4x65/100):

=88 kg N/ha

= Nitrogen requirement in artificial fertiliser:

=62 kg N/ha

~ Supply in N27 with S

Please note that the field effect is based on the 1<sup>st</sup> year effect. 10% after-impact should be added to achieve the legal requirement of 75%.

## Demand in Denmark



Slurry, cattle	75
Slurry pigs	70
Animal manure (solid) + urine	65
Deep litter	45
Sludge	45
Waste from potatoes etc.	50

# An example – 2013 quotas

Ha	Soil index	Crop	Yield, ton/ha	Quota Kg	Next year effect	Quota	Total Kg N
100	6	Winter wheat (after winter oilseed rape)	8.1	159	0	140	14,000
100	6	Winter barley	7.1	148	0	148	14,800
100	6	Winter oilseed rape	4.0	194	-19	194	19,400
49	6	Spring barley (+ catch crop, 14 %)	5.6	110	0	110	5,390
Total quota							53,590
- Effect of catch crops (25 kg N per ha):							-1,225
						150	52,365
Minimum utilization of pig slurry (applied max. LU per ha)			140 N (=1,4 LU)	X 75 pct.		105	36,645
Rest quota in mineral fertilizer						45	15,720



Part-financed by the European Union  
(European Regional Development Fund)

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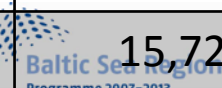
# An example

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# **The low N application rates cost Danish farmers**

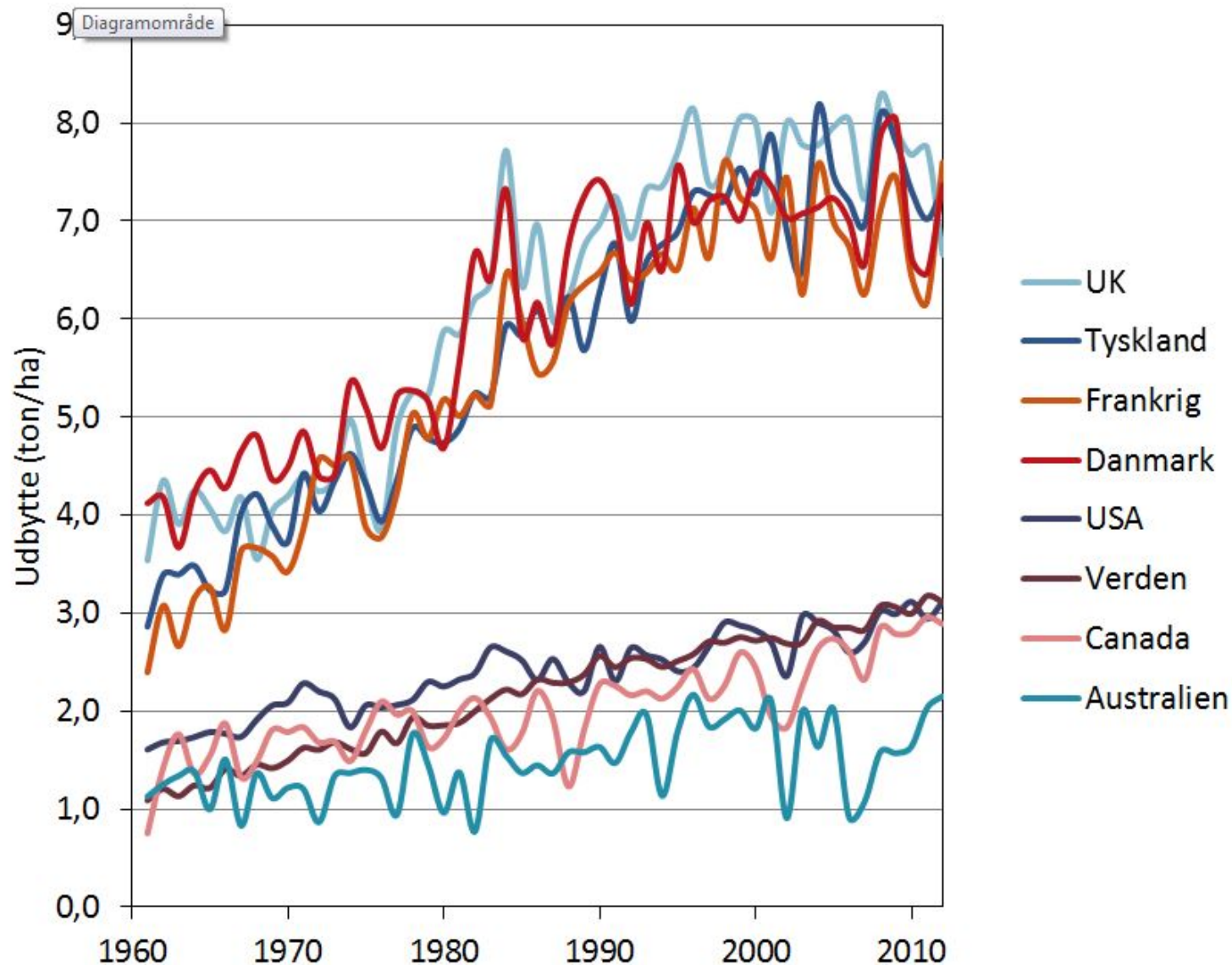
**100-250 Euros per hectare each Year**

Due to

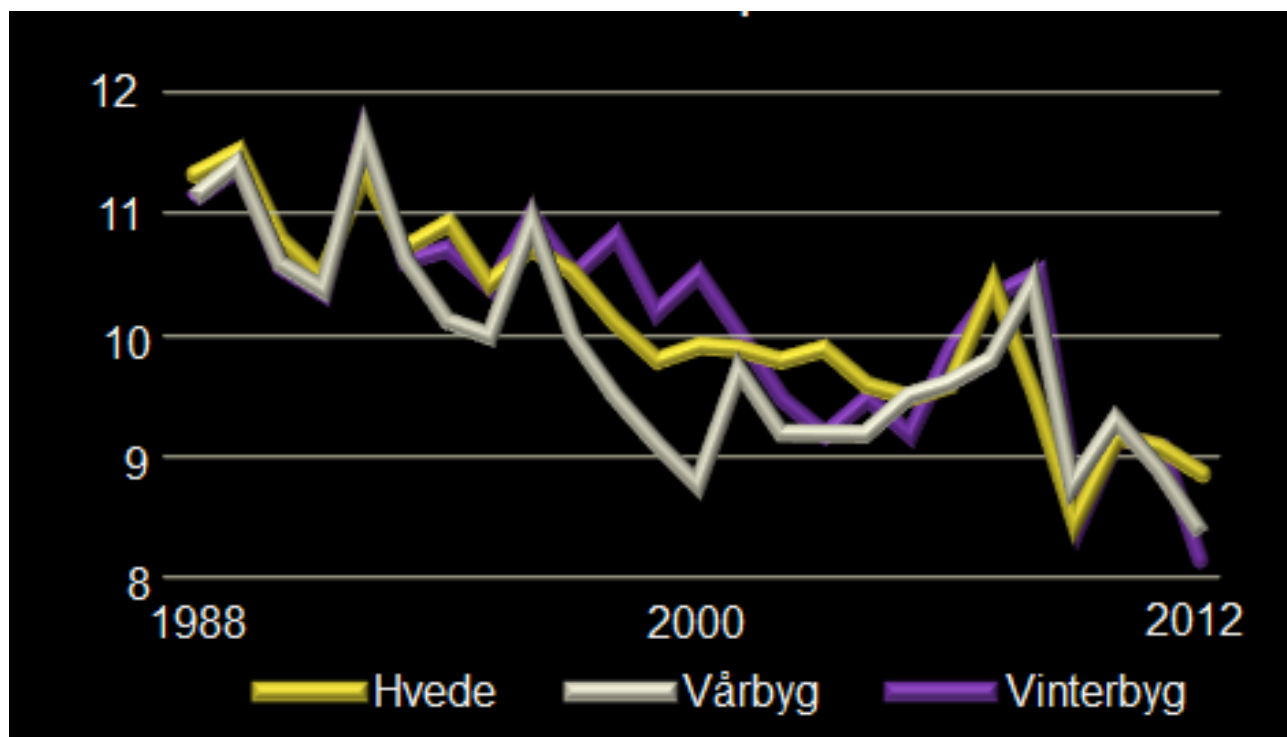
- Reduced yields
- Too low protein content

# Winter wheat yield 1960 – 2012

## Tonnes per hectare



## Protein content in Danish grain



Winter wheat – Spring barley – Winter barley



# The future



# Acidification with sulfuric acid



Field level



# The future

## Constructed wetlands



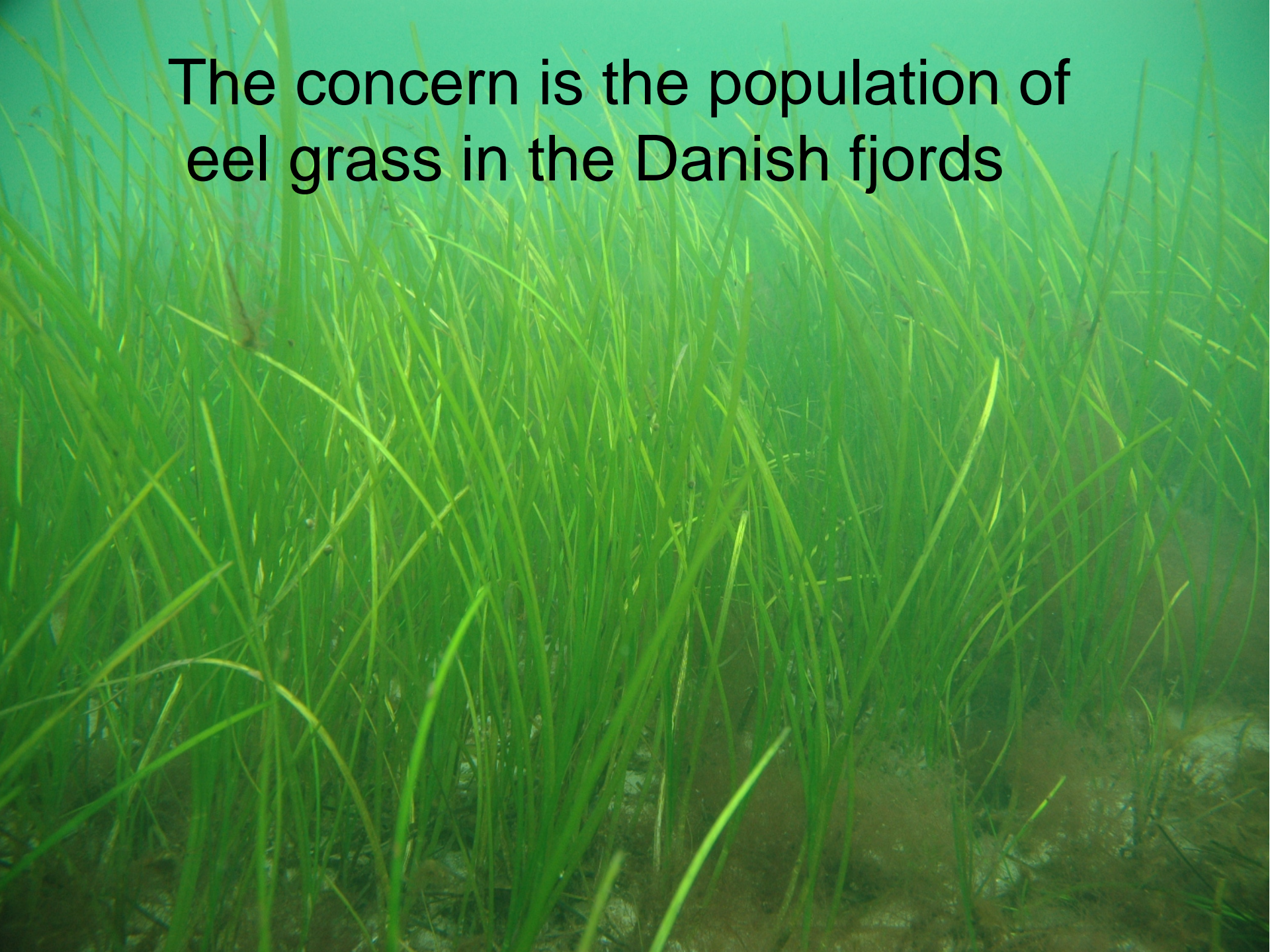
## Drainage well filters



<http://www.supremetech.dk/Danish/InDanish.htm>



The concern is the population of  
eel grass in the Danish fjords





**Thank you very much**