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Managing nitrogen in the European Union under the Nitrates Directive

Finding a balance between the benefits and costs of nitrogen fertilization

August 15, 2013 | Hans van Grinsven

1

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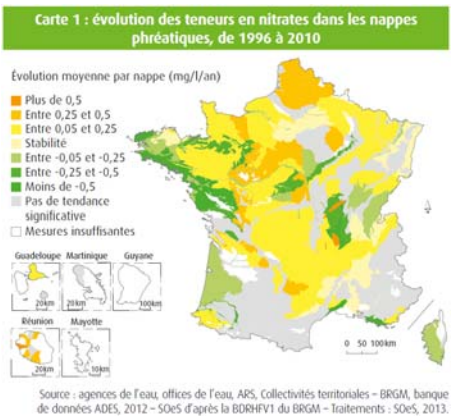
EU Nitrate Directive is still alive

France condemned over breach of nitrates directive

Environmental News Daily

14-06-2013

The Court of Justice of the EU has upheld a European Commission complaint that France breached the 1991 nitrates directive because it failed to designate a sufficient number of vulnerable areas in three river basins.



Key indicator: nitrate trend

2

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Outline

- Introduction EU agriculture
- The EU Nitrate Directive (NiD)
- Effects on N surplus and nitrate
- Evaluation of effectiveness of NiD

- Historic trend of NUE
- NUE options and future NUE
- Costs and benefits of N fertilization
- Conclusions

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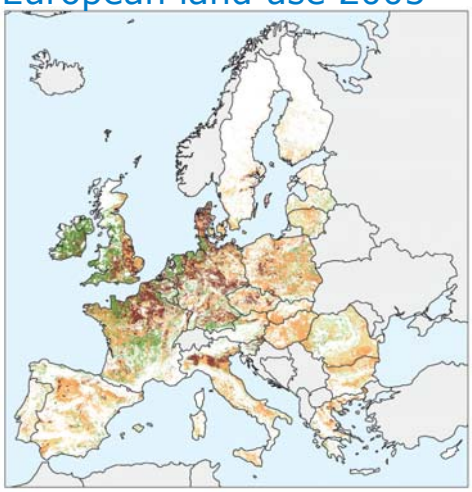
European land use 2005



Arable
- Low intensity
- Moderate intensity
- High intensity

Grassland
- Low intensity
- High intensity

- No agricultural land
- No data

55 Mha grassland
121 Mha arable land
14 Mha permanent cropland

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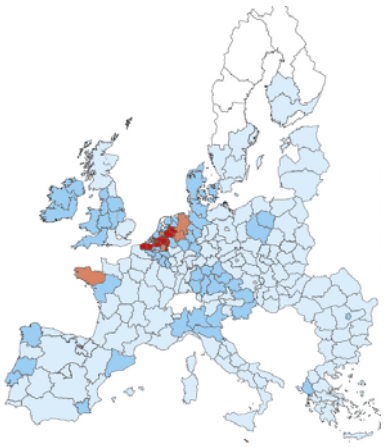
Large variation livestock density



Livestock Units/ha (2005)
- < 1
- 1-3
- 3-5
- ≥ 5

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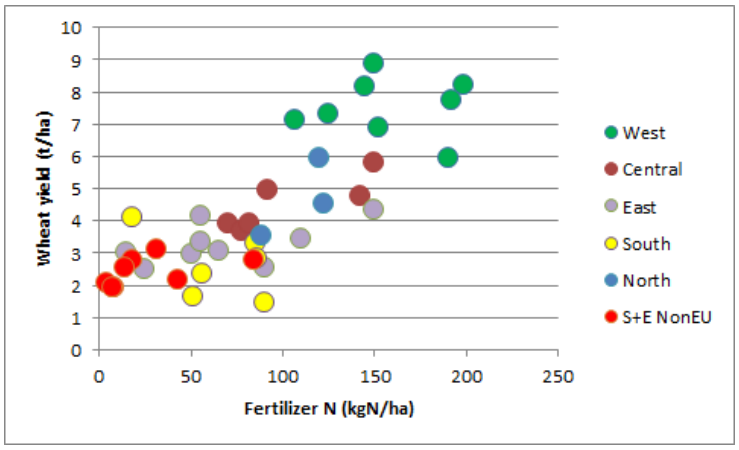
Large variation N fertilizer rates and crop yields



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Some key data EU27 vs. USA

	2005 - 2008		
		EU27	USA
Population	mln	497	304
Agricultural area	mln km2	1.9	4.2
Fertilizer use	Tg N	10.5	11.4
CNF	Tg N	0.7	8.3
Feed/Food import	Tg N	3.5	-1.5
Manure production	Tg N	8.9	8.7
N-surplus	kg/ha	50	35

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Characteristics of agricultural sector in NW EU

	Agricultural area (UAA)	Livestock density	Permanent Pasture	Farm size
	mln ha	LSU/ha*	% of UAA	ha UAA/ holding
Belgium	1.4	2.8	37	29
Denmark	2.7	1.7	8	60
France	27.5	0.8	29	53
North-central**	17.8	0.9	21	-
Germany	16.9	1.1	29	46
Ireland	4.1	1.4	76	32
Netherlands	1.9	3.4	43	26
United Kingdom	16.1	0.9	62	65
EU27	172.5	0.8	33	13

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Gross N balance 2005-2008 (Eurostat, 2011)

	Inorganic fertilizer	Gross manure	Other inputs	Removal	Gross N balance
			kgN/ha		
Belgium	101	168	41	191	119
Denmark	75	100	24	101	98
France	76	62	26	112	52
Germany	103	74	42	125	93
Ireland	78	117	15	155	55
Netherlands	140	236	28	194	210
United Kingdom	94	87	31	111	101
EU15*	67	63	26	98	58
EU27	61	54	25	89	50

*EU15: member states between 1 January 1995 and 30 April 2004

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Implementation EU Nitrates Directive (1991)

1. Detection of polluted or threatened waters (50 mg/L NO_3)
2. Designation of Nitrate Vulnerable Zones (NVZ - only agric. sources)
3. Codes of GAP. (1993) Non-statutory
4. Action (4 yrs) Programmes within NVZ's. From 1998. Mandatory measures (a.o. 170 kgN/ha)
5. National monitoring and review and reports (4 yr) water quality and impacts
6. Review and revision NVZ's and Action Programmes

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Farm measures to implement NiD

	DK	BFL	FR	GE[1]	UK	NL	IRL
Farm measures							
Fertilizer planning							
Keeping records	yes	yes	yes	yes	yes	yes	yes
Soil analysis	yes	yes[2]		yes		yes[2]	
Fertilization							
Closed periods for manure/fertilizers[3]	yes	yes	yes[4]	yes	yes	yes	yes
Low emission application	yes	yes				yes	
No manure application on frozen, snow covered and waterlogged land	yes	yes	yes[4]	yes	yes	yes	yes
Unfertilised zones along surface water[5]	yes[6]	yes	yes[4]	yes	yes	yes	yes[7]
Post-harvest measures							
Catch crops	yes		yes[4]			yes	
No tillage in autumn	yes						yes[8]
Other Policy Measures							
Max limit for livestock	yes						
Maximum limits on N and P use							
Manure	yes	yes	yes	yes	yes	yes	yes
Total N (manure + fertilizers)	yes	yes	yes[4]		yes	yes	yes
Maximum N and P surpluses				yes			
Maximum soil mineral N in autumn		yes	yes[9]	yes[1]			

DK = Denmark, BFL = Belgium Flemish Region, FR = France, GE = Germany, UK = United Kingdom, NL = The Netherlands, IRL = Ireland

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Statutory nitrogen fertilizer equivalency for manures (%)

	Cattle slurry	Pig slurry	Layer solid manure	Broiler solid manure
Netherlands	60	60-70	55	55
Flemish Region	60	60	30	30
Denmark	70	75	65	65
France*	50-60	50-75	45-65	45-65
Germany	50	60	30	30
United Kingdom	20/35	25/50	20/35	20/30
Ireland	40	50	50	50

*No legal status

Source: Webb et al., 2013

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Overview of area in Nitrate Vulnerable Zones and derogations (mostly dairy)

	Nitrate Vulnerable Zones area (%)	Application limit for manure (kg N/ha)	Share of Agricultural land (%)	Share of farms (%)
Belgium	68			
Flemish Region	100	250/200[1]	12	10
Walloon Region	42[2]			
Denmark	100	230	4	3.2
France	45	170	0	0
Germany	100	230	< 1	<1
Ireland	100	250	8	8
Netherlands	100	250	45	32
United Kingdom	39	250	1.5	1.3

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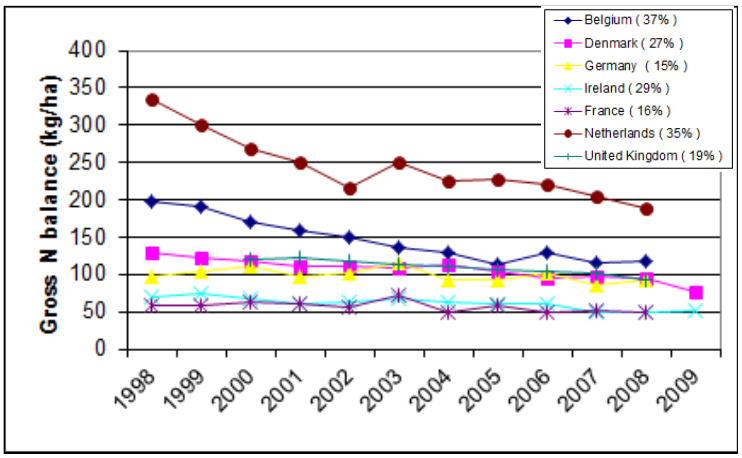
Trend gross annual N balance



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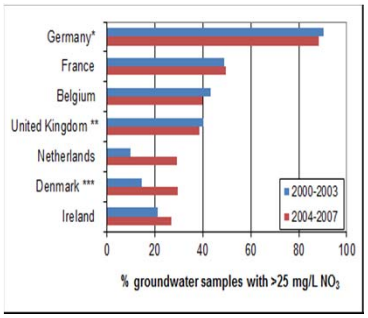
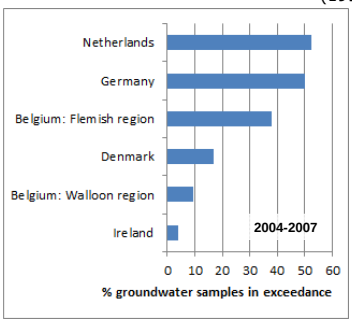
Exceedance in groundwater - observations

All samples



Shallow groundwater

mg/l/yr NO_3 (1992-2010)



6
0.6
0.7
2
0.3

Time trends and differences between countries in part artefacts of different monitoring!

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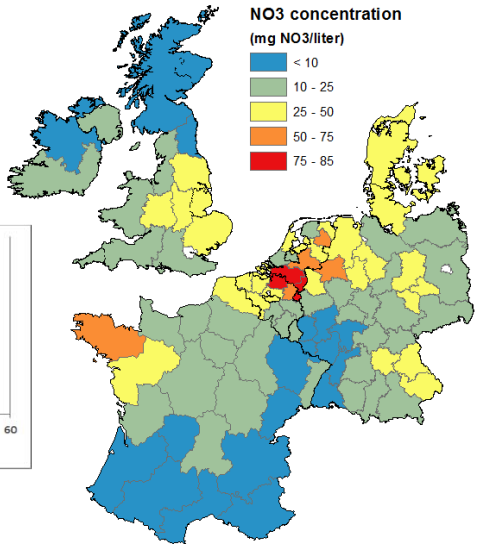
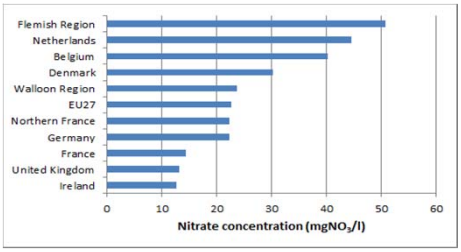
Nitrate in leaching water from the root-zone in 2008 - model





(MITERRA)

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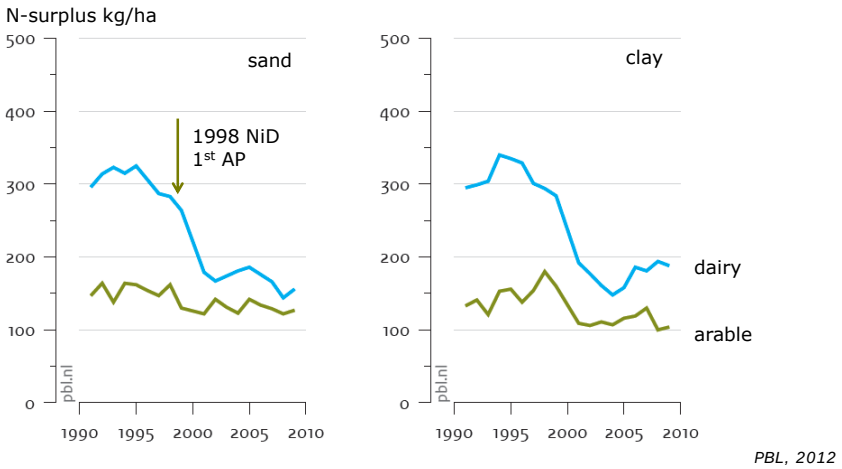
Dutch dairy: 50% reduction N-surplus



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EU Nitrate Directive was successful

1. Pressured all EU farmers (and their advisers) to act
2. New arrangements to revise/review Action Programs
3. Stopped / reduced manure dumping
4. More efficient use of fertilizer and manure N; no yield loss
5. Modest improvement of water quality
   - Largest effects in Denmark, Netherlands and Belgium-Flemish R.

Other factors:

- Milk quota (1984), McSharry reform (1992)
- NEC directive (1 Tg NH_3-N savings in manure since 1980)
- Price increase fertilizer relative to crops (wheat: 4-'94 $\rightarrow$7-'08)
- An increase of crop yields up to 1995 (wheat: 0.1 ton/yr)

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Claims of failure in NiD?

Farm perspective

1. Administrative burden of record keeping
2. Disturbance of level playing field EU livestock farming
3. No reward system – e.g. cross compliance EU farm subsidies
4. 50 mg/L NO_3 unachievable sandy soil / low net precipitation
5. Creation of obscure (pseudo) markets for manure (NL)

Policy perspective

1. NVZ designation tedious process
2. Sensitive to fraude – uncertain compliance
3. Did not stop / reverse livestock hot spots
4. Lack of hamonized monitoring guidelines

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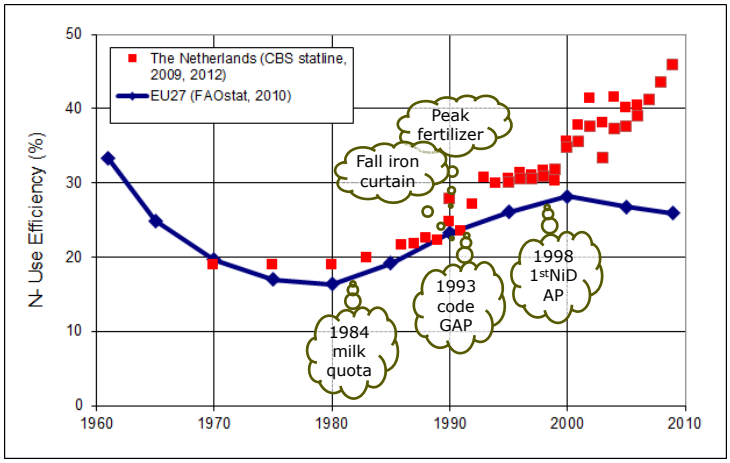
NUE agricultural sector in EU27 and Netherlands



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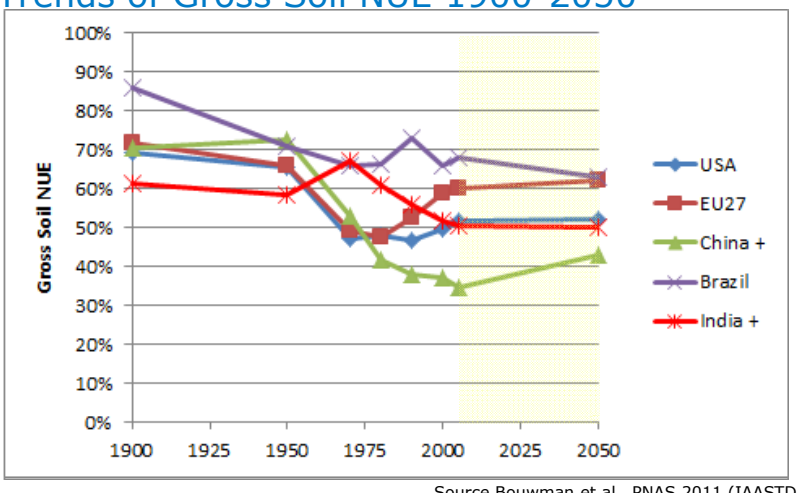
Trends of Gross Soil NUE 1900-2050



Source Bouwman et al., PNAS 2011 (IAASTD - baseline)

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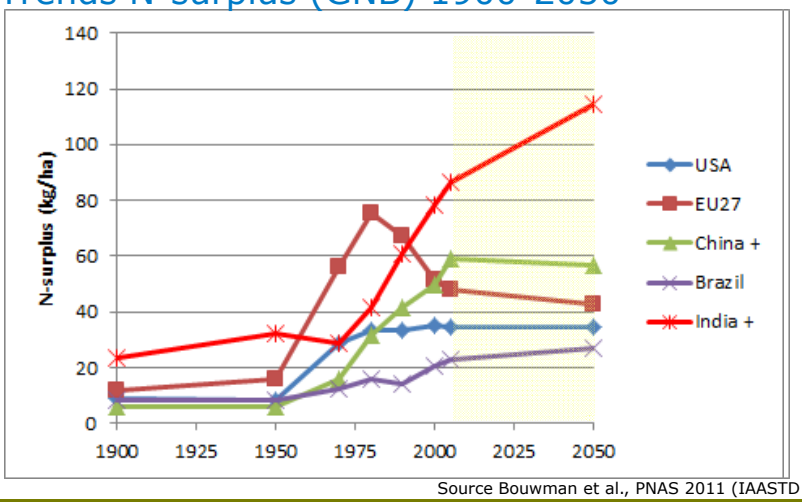
Trends N-surplus (GNB) 1900-2050



Source Bouwman et al., PNAS 2011 (IAASTD - baseline)

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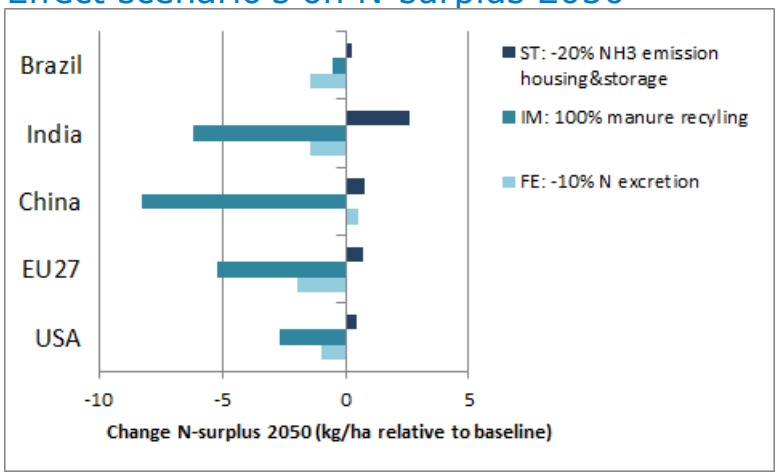
Effect scenario's on N-surplus 2050



Source Bouwman et al., PNAS 2011

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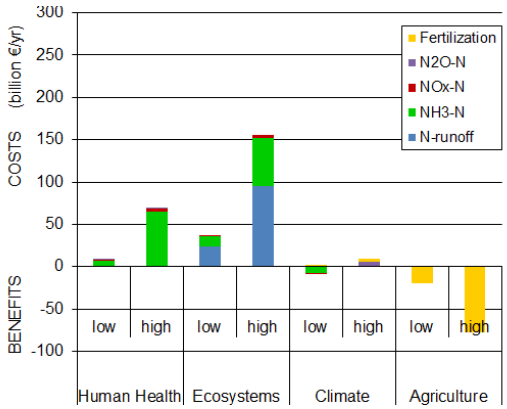
Costs and benefits of N EU27 in 2008

Agricultural sources



N pollution cost:
35-230 billion euro/yr

N crop benefits farm:
20-80 billion euro/yr

N cost > N benefits??

(Grinsven et al., ES&T 2013)

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Costs and benefits of N - fertilization

Unit costs and benefits of N: N application to loamy sand							
				CAN		50/50 CAN-Manure	
		€/kg N emission		€/kg N use		€/kg F-eq N use	
		low	high	low	high	low	high
Nitrate groundwater	Health	0	4	0.0	1.4	0	1.6
N-load surface water	Ecosystem	5	20	0.3	4.0	0.4	5.3
NH3-emission to air	Health	2	20	0.0	0.5	0.3	8.4
	Ecosystem	2	10	0.0	0.4	0.3	4.2
Crop yield increase	Farm econ.			0.5	3.0	0.5	3.0
	Food econ.			1.0	6.0	2.0	6.0
Net benefit	Farm econ.			2.7	-5.8	2.0	-19.0
	Food econ.			5.7	-3.9	5.0	-15.9

(Grinsven et al., ES&T 2013)

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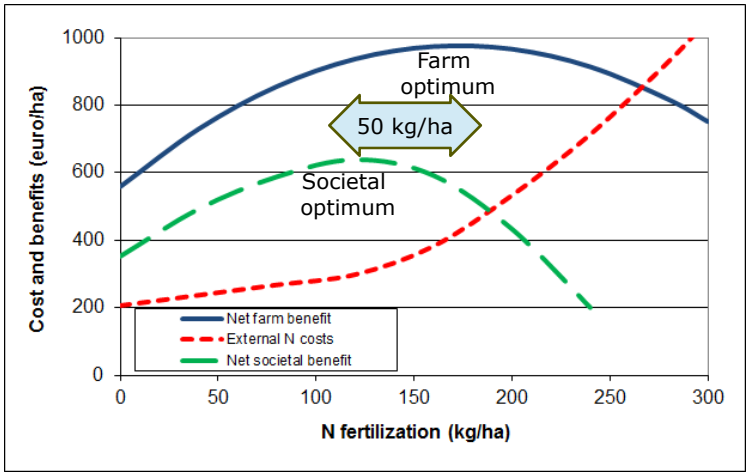
What is the societal optimal N rate for wheat?



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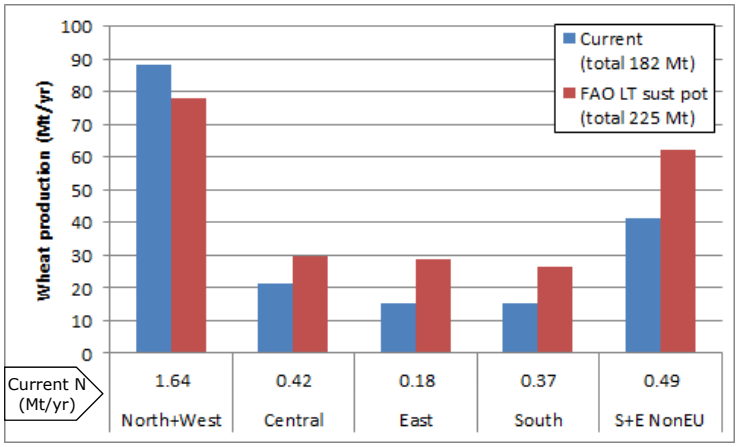
Yield loss in NW EU can be compensated



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Costs and benefits – Netherlands

Annual costs (2010 – Meuro)	
Farms	
▪ Manure transport	200
▪ Manure administration	70
▪ Manure storage	70
▪ Manure LE application	60
▪ Housing NH_3 reduction	*~50*
Total cost	450
Manure cost livestock farm (15-30 Keuro/yr)	
Society	
▪ Control costs	30

Annual savings/benefits	
Farms (since 1990)	
▪ Fertilizer savings	200
– *ammonia share*	*100*
▪ Yield reduction	0
Total NUE savings	200
Society (since 2000)	
▪ Reduced NO_3 pollution	100-400
▪ Reduced NH_3 pollution	100-900

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Four M-words to increase NUE

- Manure
  - efficient recycling of manure
- Mindset
  - train/reward/punish, risk aversion
- Money (Market)
  - Farmer: cost/income; citizen: taxation/risk sharing
- Menu
  - NUE food system: reduce meat/beef

NUERO-SCIENCE: NUE, euro's, neurons

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Thank you

and my co-authors and co-thinkers

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