Ammonia reduction within the UK

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Background to NH_3 emissions in the UK

General information about UK NH_3 emissions

Livestock housing types

Manure application techniques

Share of small and large farms

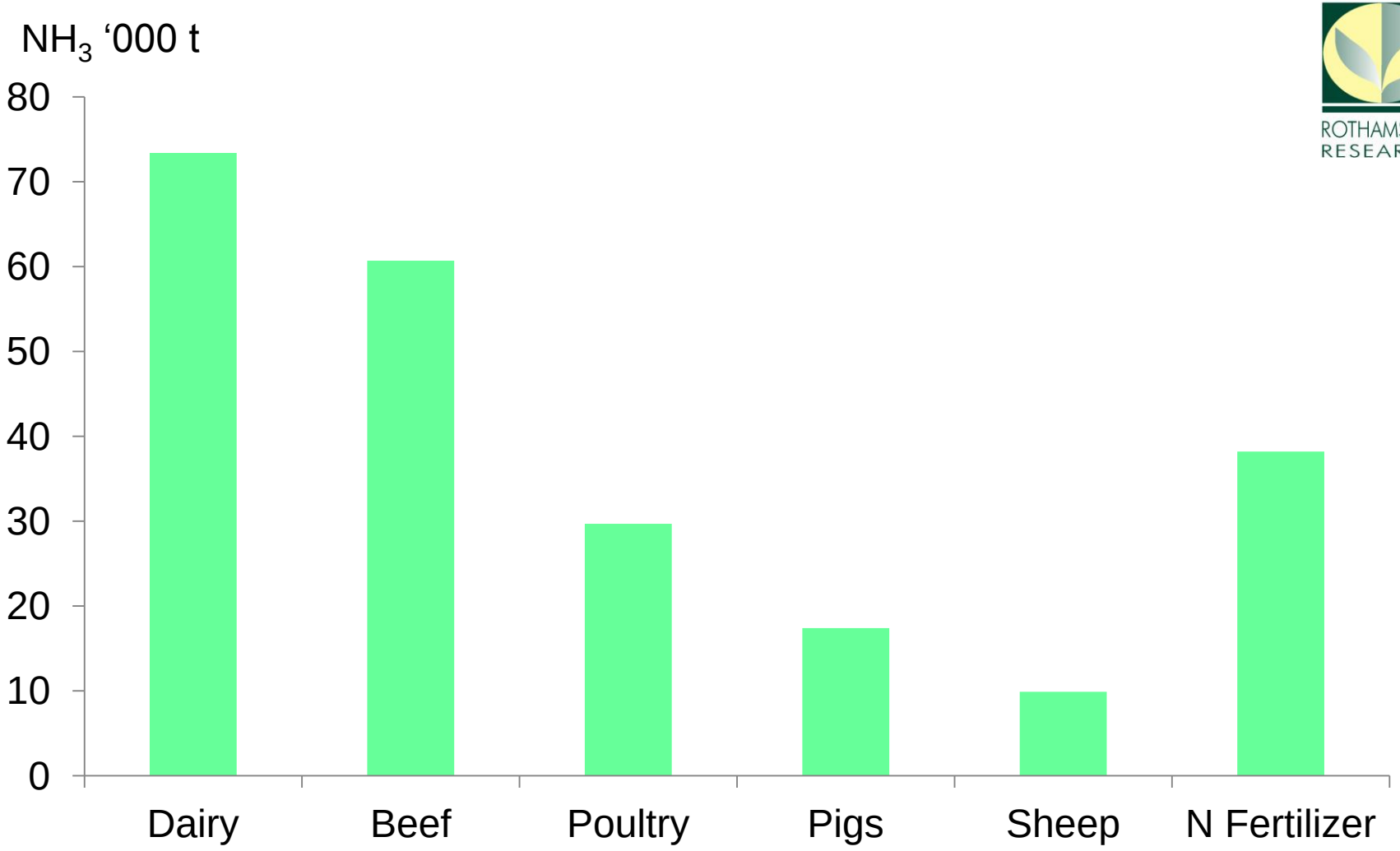
Share of solid and liquid manure

Ammonia hot spot areas

Manure problems

Other related nitrogen problems

UK NH_3 emissions from agriculture - 2010



UK NH_3 emissions from livestock 2010 – by source/activity

Livestock housing types - cattle

NH_3 emissions from buildings account for 32% of livestock total

In the UK buildings housing cattle are:

- naturally-ventilated
- and of many different shapes and sizes

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Outdoor collecting and feeding yards are the source of *c*. 11% of NH_3 emissions from livestock

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Manure storage

Accounts for 15% of livestock total

around half of cattle and pig manure is stored as slurry

- in lagoons
- above-ground tanks
- ‘weeping wall’ stores (cattle slurry)

solid manure stored in heaps on farm yards or fields

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Manure spreading

Accounts for 27% of total from livestock

Most manure, both slurry and solid, is applied to the surface

- on arable land incorporation may be within a few hours but more usually left for days or weeks
- about half of manures are applied to grassland and most remain on the surface until washed into soil/grown over by grass

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Farm size in the UK - dairy

Average dairy herd around 130 cows

Between 1999 and 2009 number of farms went from 30,200 to 16,400

Average milk yield 7500 L/cow 2011

- 6500 L/cow in 2001

Median size 50-100 ha

Average N fertilizer use on grass around 150 kg/ha

- plus all the manure

Farm size in the UK – arable and beef

Arable

- median size >100 ha
- average N fertilizer use on wheat 190 kg/ha

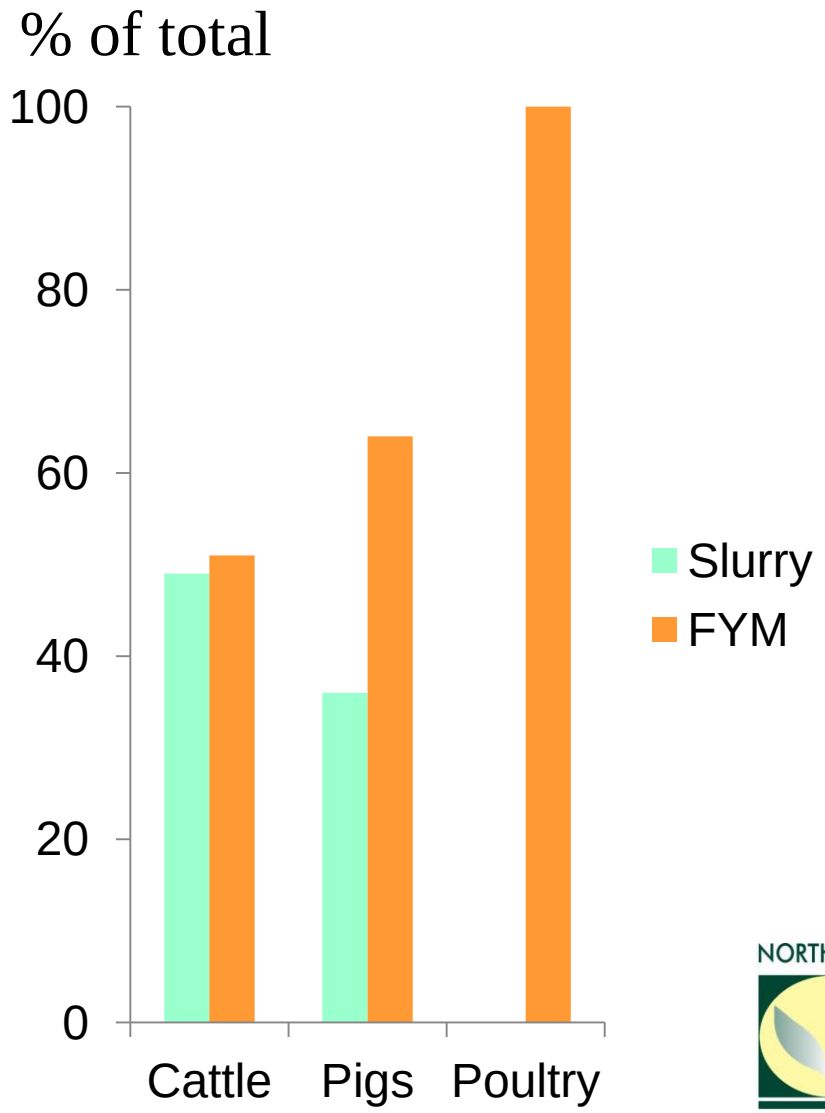
Beef and sheep

- median size 25-50 ha
- average N fertilizer use on grass not available for beef
- but < 50 kg/ha

Share of solid and liquid manure

Prpportions of manure not as weight

but as manure N going into store



Other related nitrogen problems

Around 55% of the UK is in a Nitrate Vulnerable Zone

Annual losses of Nitrate are *c*. 300,000 t N

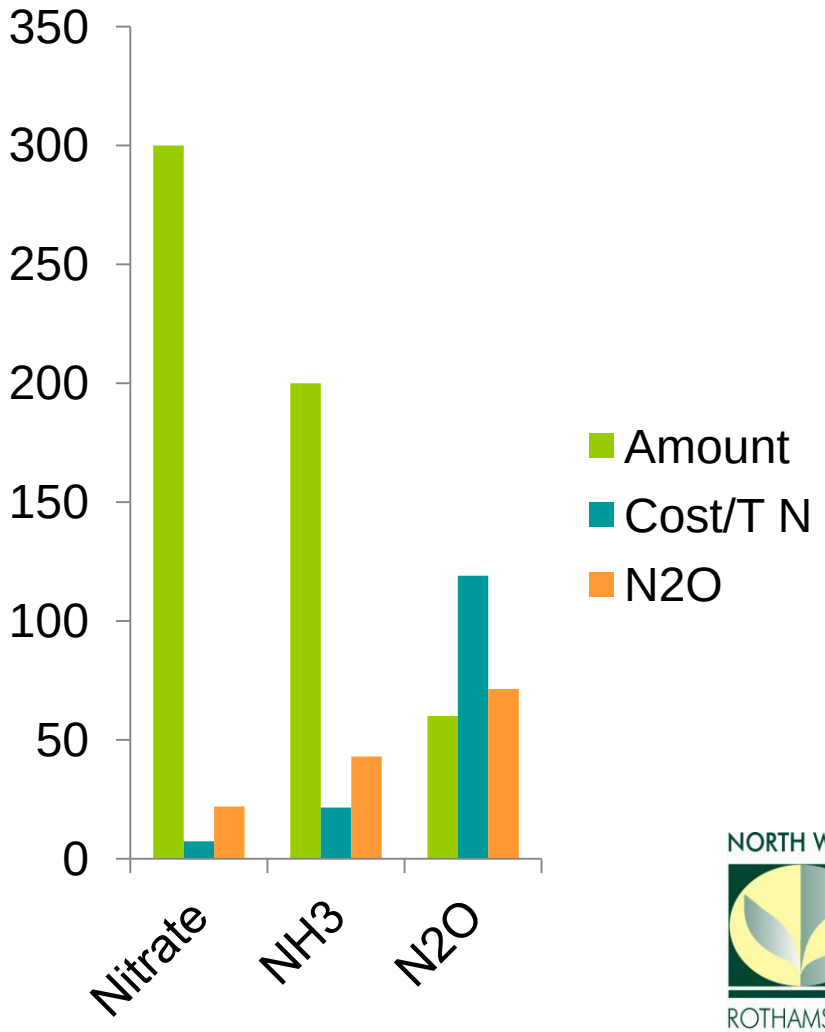
Nitrous oxide

Around 60,000 t N per year

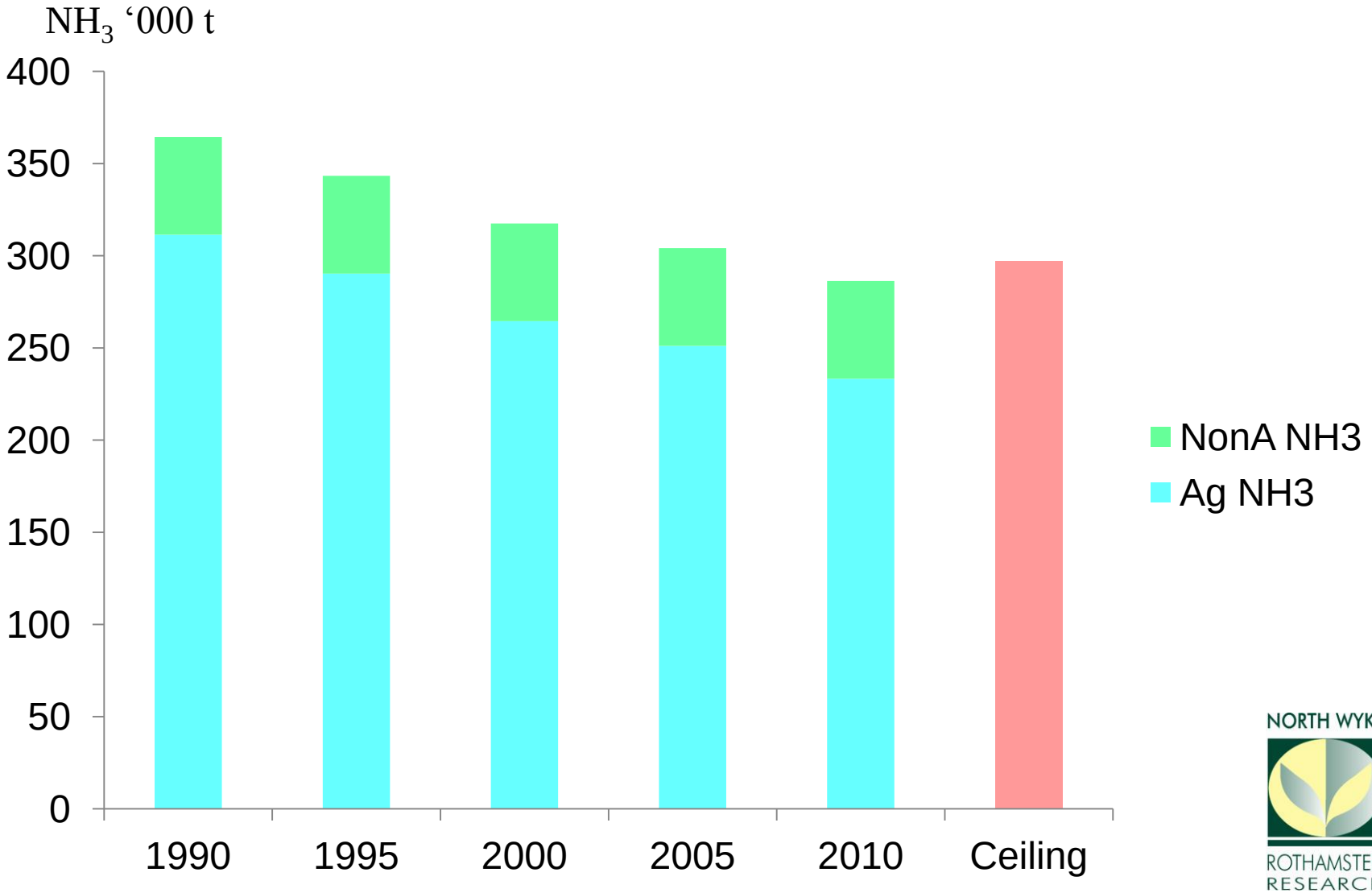
N losses – what is the cost?

The amounts of N lost as nitrate exceed those of NH_3 and N_2O combined

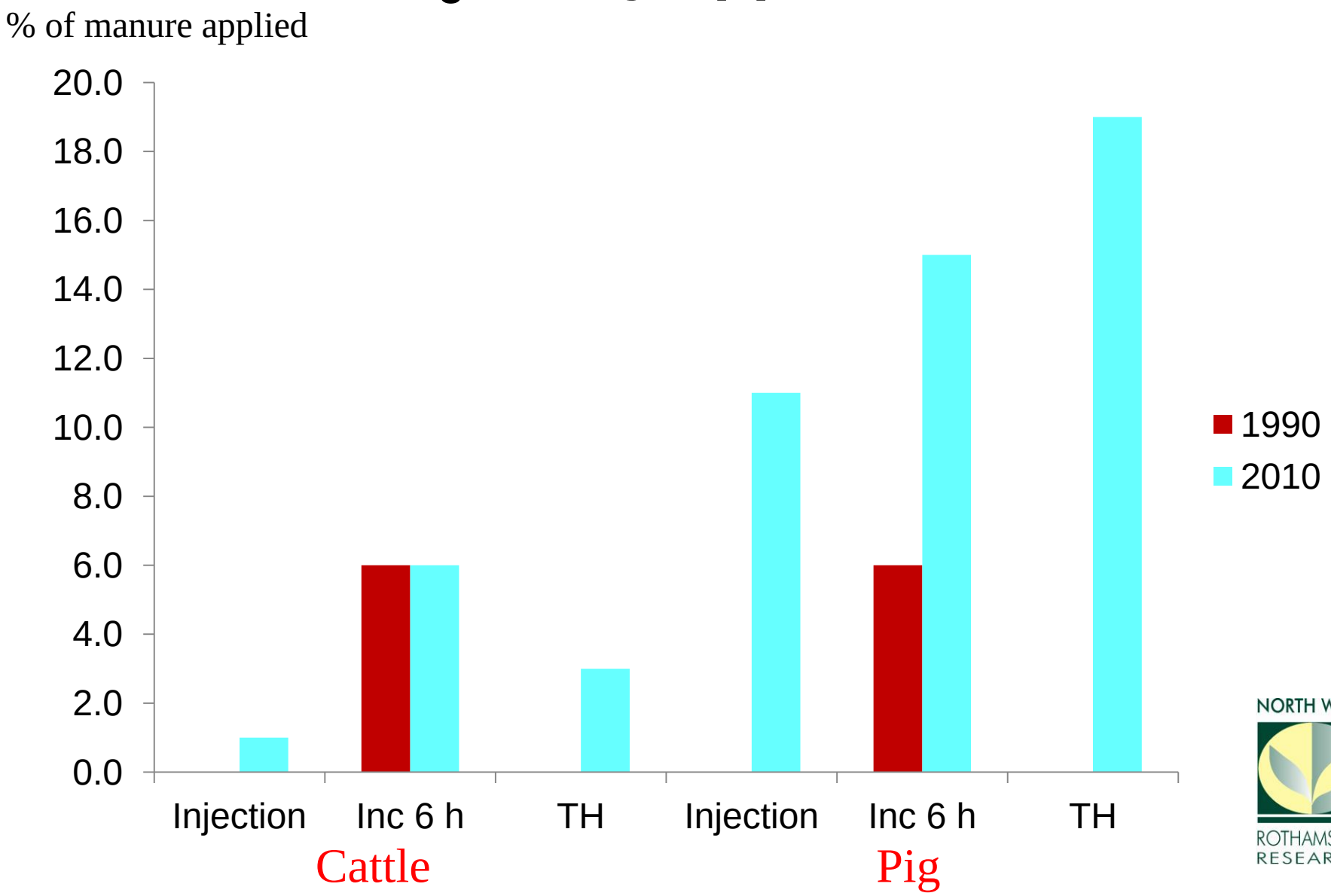
But the estimated costs of the impacts are very small for nitrate and large for N_2O



UK NH_3 emissions 1990 – 2010 and Gothenburg ceiling



What activities have been successful? Reduced NH_3 slurry application



Solid manure application within 4h

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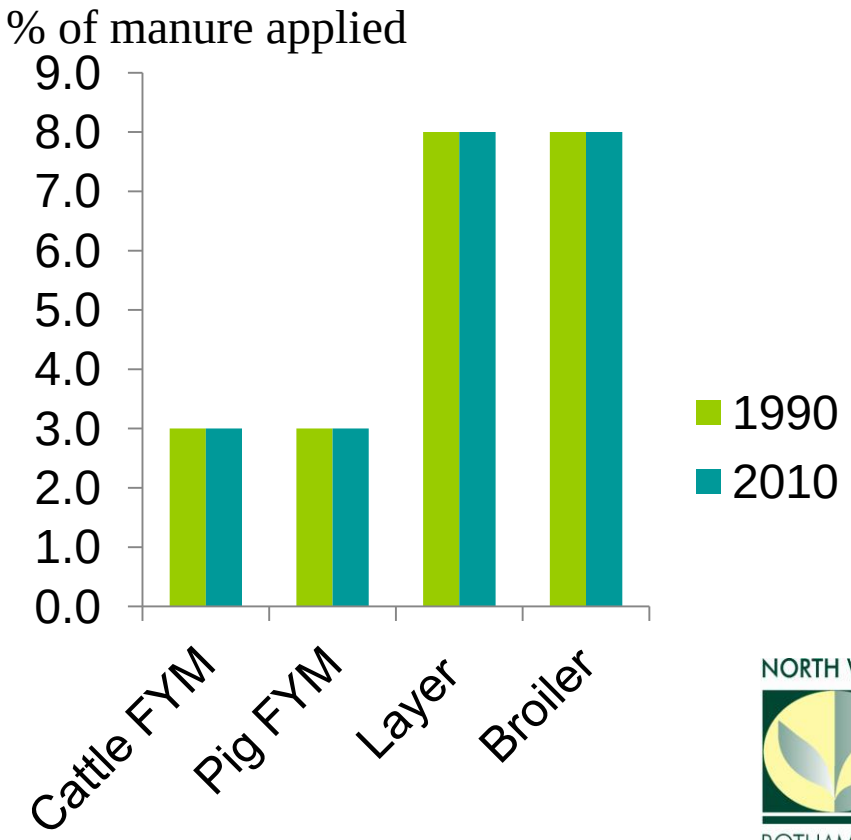
- Rapid incorporation of solid manure
- rapid incorporation of solid manure can be very effective in reducing NH_3 emissions
- up to 90%
- providing incorporation immediately after application
- thereafter effectiveness greatly decreases

Rapid incorporation of solid manure 1990-2010



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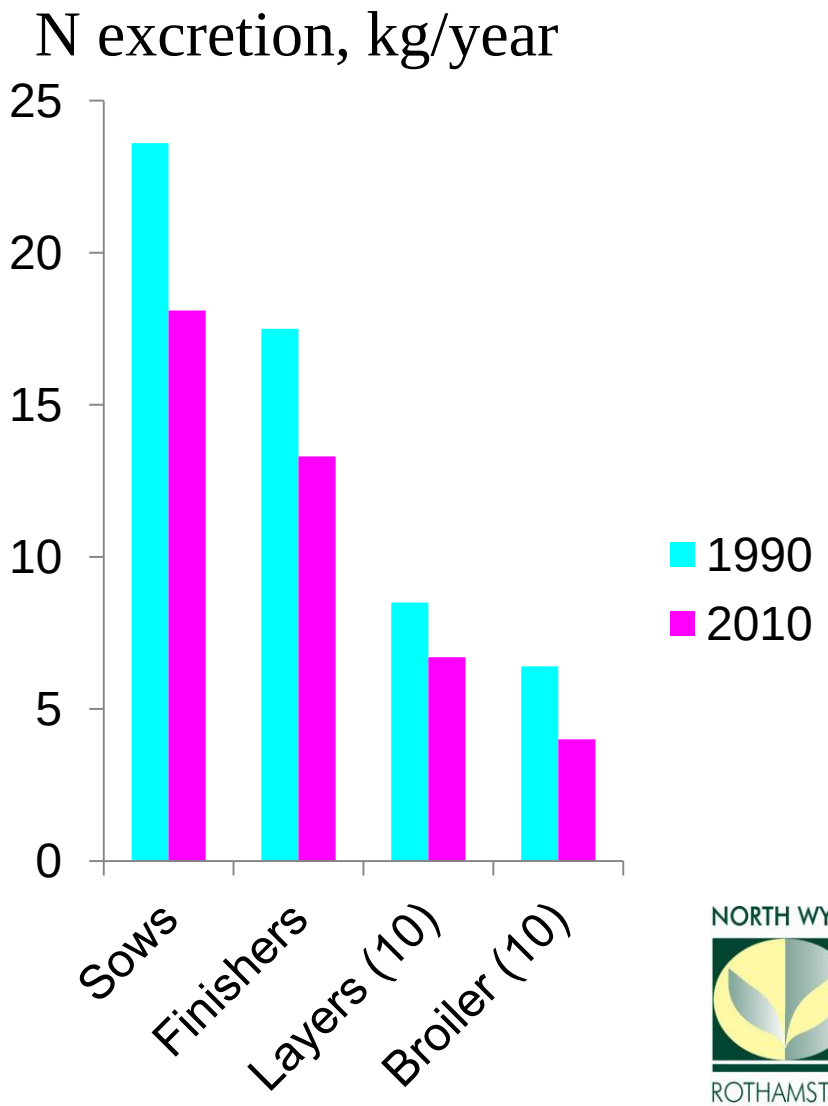
Currently no data to show trend in 4h incorporation

Reduced protein content in feed – reduced N excretion

There have been considerable reductions in the protein concentrations of pig and poultry feeds since 1990

By between 21 and 38%

Effect on total emissions moderate as pigs and poultry only 25% of total NH_3 emissions from livestock



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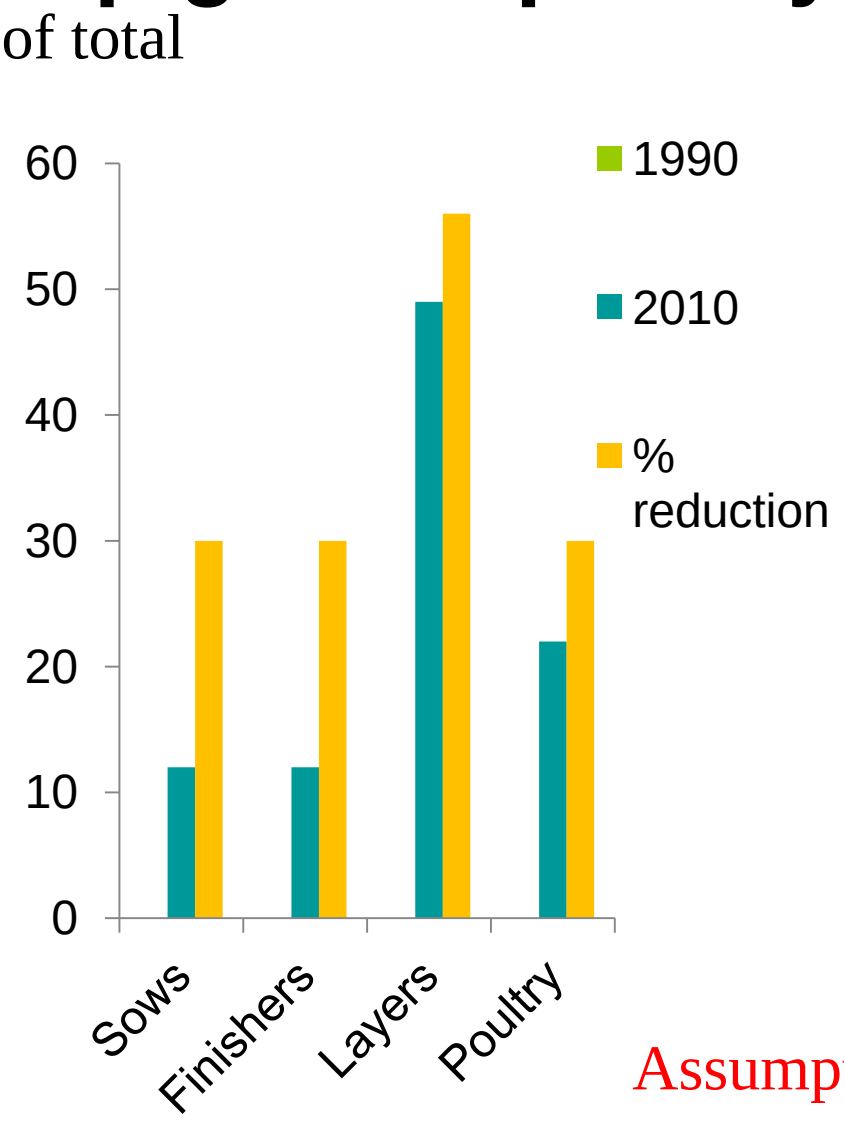
Introduction of IPPC and BAT - pigs and poultry



Assumption is all zero for 1990

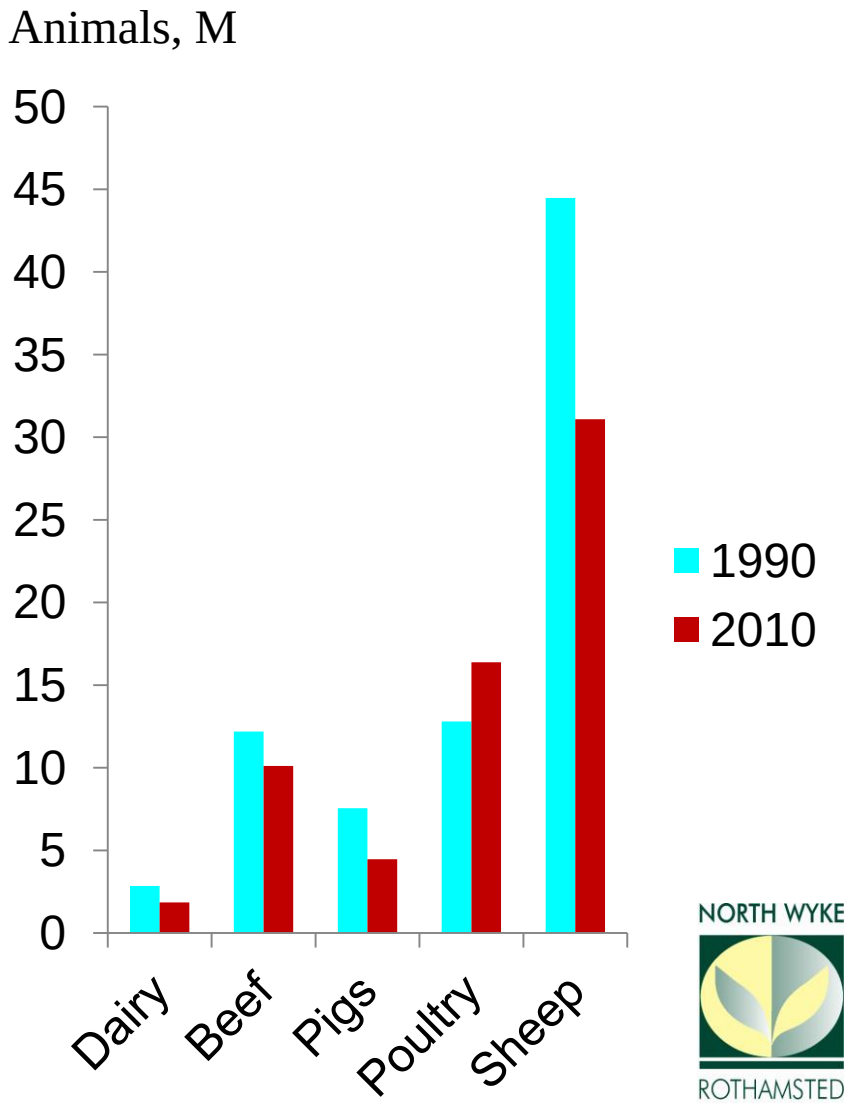
Decrease in livestock numbers

Although N excretion by dairy cows has increased

- From 90 to 120 kg

N excretion by beef and sheep is unchanged

N excretion by pigs and poultry is less



What problems are faced and what solutions have been chosen?

The UK has not faced any problems in complying with the requirements of the Gothenburg protocol

- reductions in livestock numbers
- reductions in the N contents of pig and poultry feeds
- some adoption of reduced NH_3 emission spreading techniques
- and some uptake of BAT to comply with IPPC
- have all lead to reductions in NH_3 emissions to less than the required target

What problems are to be addressed in the future in connection with the country's obligations to the Gothenburg Protocol?

What will the revised ceiling be?

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What should be done in research and in practice?

In our view the origin of emissions are well understood and effective means to reduce them have been demonstrated

Priority given to:

- reducing N in diet and reducing N excretion which reduces NH_3 emissions at all stages of manure management
  - and reduces other N losses
- reducing emissions following application
  - among the most cost-effective of measures
  - and NH_3-N conserved at this stage will not be lost subsequently

What should be done in research and in practice?

Although buildings housing livestock are now the largest source of UK NH_3 emissions there are problems with reducing emissions from them

- buildings housing cattle are naturally-ventilated allowing free exchange of air
- measures to reduce emissions from buildings tend to be expensive
- and often only moderately effective (30-50%)
  - measures for stores and application can reduce NH_3 emissions by 60-90%
- and unless measures are also used to reduce NH_3 emissions during storage and after application
- much of the NH_3 conserved in buildings may be subsequently lost

What should be done? Potential problems

In the UK emissions from the use of N fertilizer are relatively small

- 1.8% of N applied
- this is because most N fertilizer is applied as ammonium nitrate

New fertilizer factories produce urea

- potentially large emissions from urea use
- 9.8% of N applied in UK
- most N is top-dressed in UK so incorporation not an option
- need to develop/demonstrate effective inhibitors that
  - reduce NH_3 emissions
  - but do not reduce crop N uptake leaving N residues after harvest that can be lost as NO_3 and/or N_2O

What should be done? Potential problems

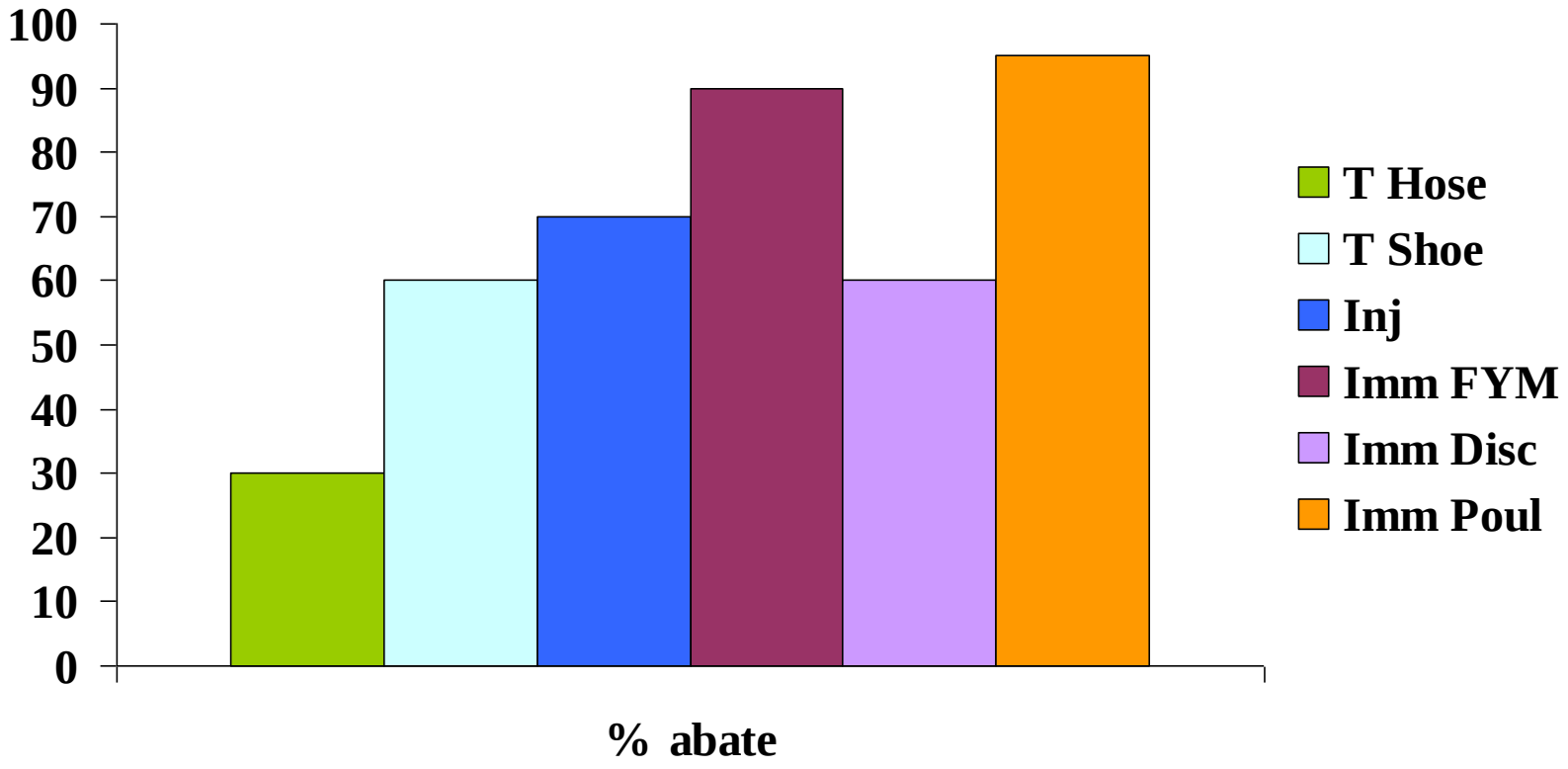
Concerns over animal welfare may lead to increased NH_3 emissions from livestock buildings

- studies in the UK and DK have indicated emissions increase with the area allowed per animal
  - EU Directive banning small cage systems for laying hens has led to replacement of buildings with types that potentially emit more NH_3
  - programme of work proposed to measure emissions from these new welfare-friendly buildings
- free range poultry production may also lead to increased emissions
  - birds more active and eat more and excrete more N

What should be done? Potential problems

Interest in much larger livestock units

- proposals for 8000 dairy cow herd in England
  - cattle would be housed continuously potentially greatly increasing NH_3 emissions
  - however, GHG emissions might be reduced under such a system
  - due to diet no longer being grass based
- proposals for 2000 sow pig unit as well
  - closed ventilation system would greatly reduce NH_3 emission
- both proposals rejected due to concerns over welfare and nuisance to neighbours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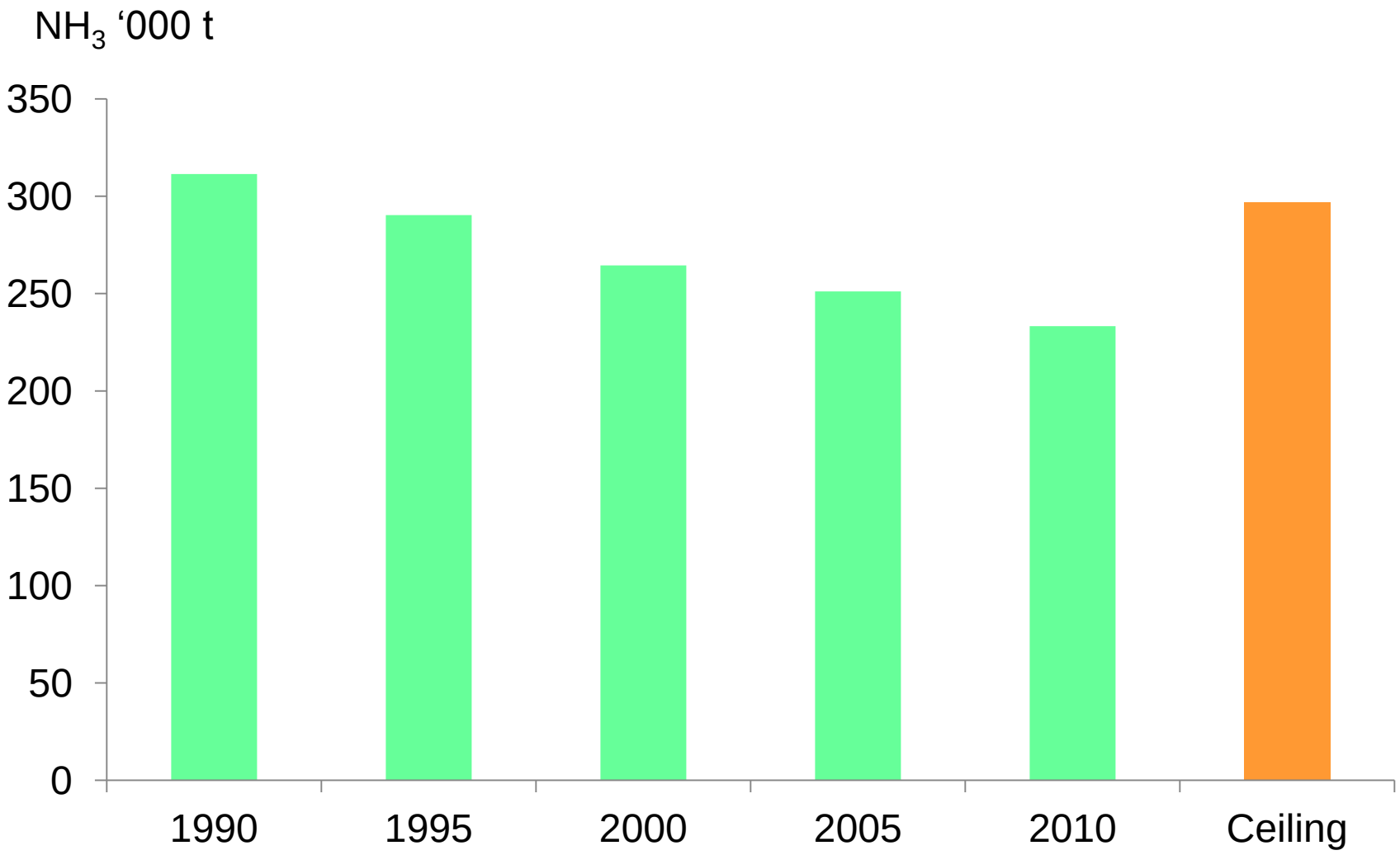
Immediate incorporation

UK NH_3 emissions 1990 – 2010 and Gothenburg ceiling



Slurry injection - photos

Injection of slurry has been reported to increase ANR compared with broadcast surface application by an average of 11%

- when no damage was caused to the crop by injection

Trailing shoe

The NFRV has been reported to be strongly influenced by the month in which manure was applied

- increasing from 0.30 to 0.40 when applied in April
- but from 0.14 to 0.24 when applied in June

later grass cuts do not use N as efficiently as the first cut

- this is due to less crop growth
- perhaps more NH_3 volatilization under warmer conditions and
- greater denitrification in autumn compared with spring or because of immobilization associated with root death

results support the conclusion that better utilization can be achieved by applying N in diminishing amounts over the growing season

Trailing hose

Application of slurry on cereal crops by TH may reduce NH_3 volatilization compared with broadcast application

the difference increases with increasing crop height

N recovery from slurry is also expected to be greater when using TH in growing crops

however, application on bare soil by TH has little effect on N losses

the results of application to grassland are intermediate