

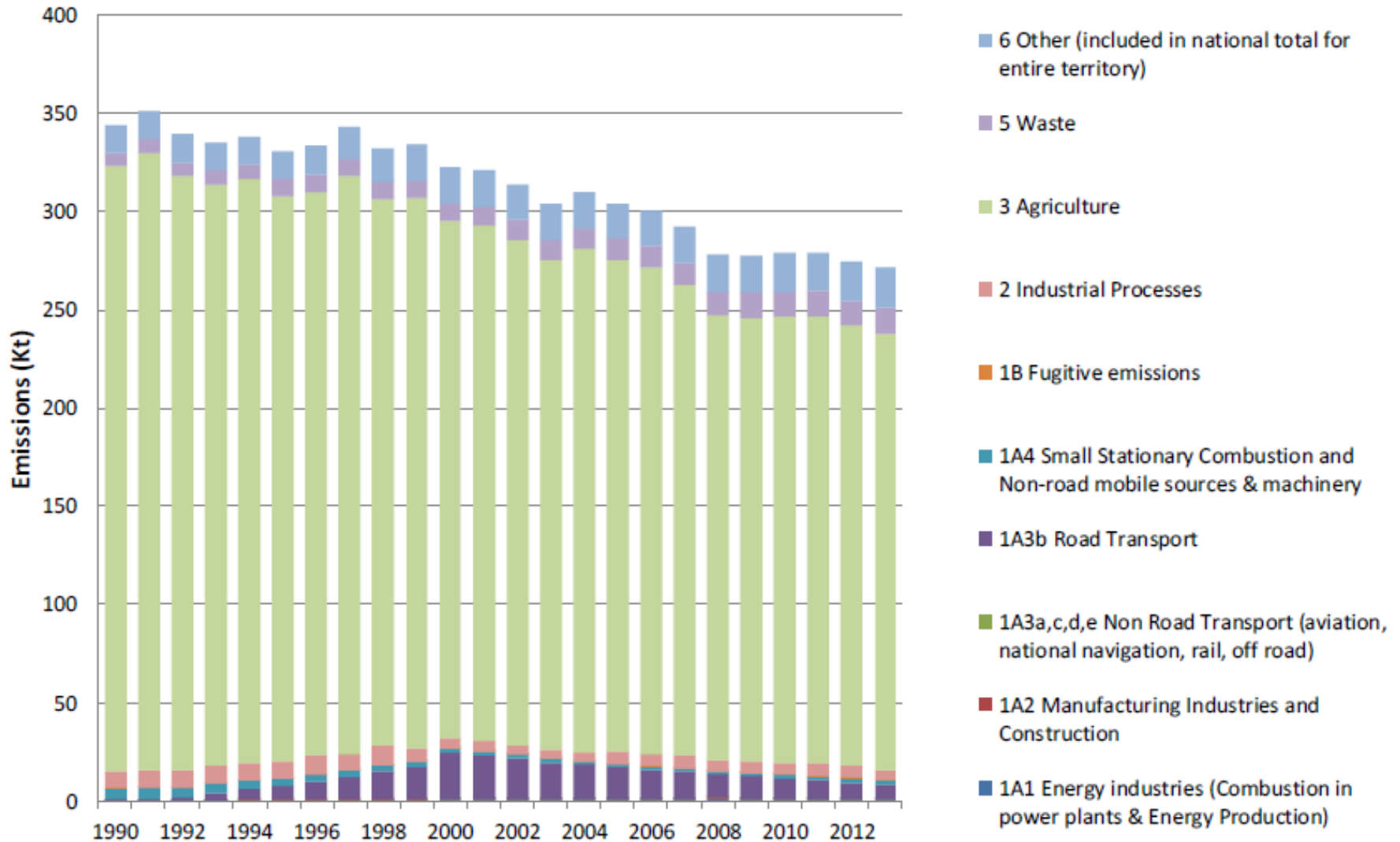
# Ammonia emissions from UK agriculture: Quantification and mitigation

Tom Misselbrook



# UK total for 2013 265 kt NH<sub>3</sub>

## Total UK NH<sub>3</sub> Emissions by Source Sectors



# Ammonia - overview

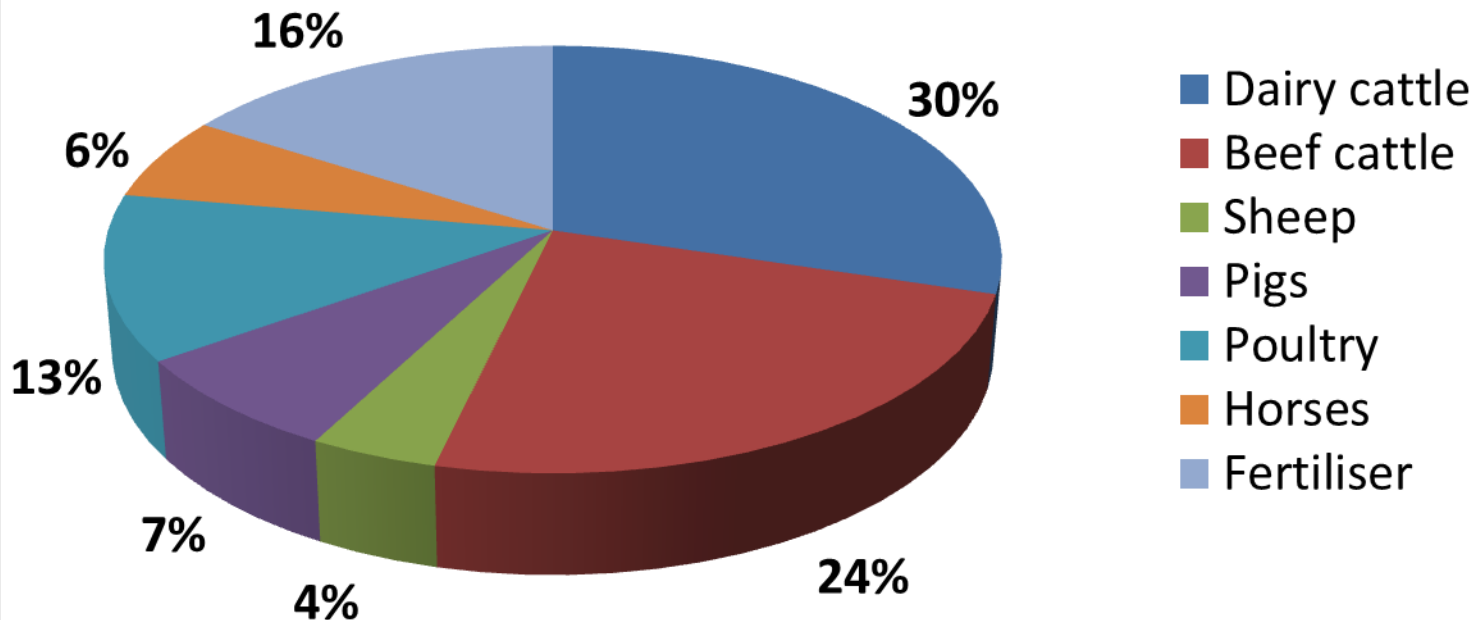
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**Air quality pollutant**

**Particulate formation, eutrophication, acidification**

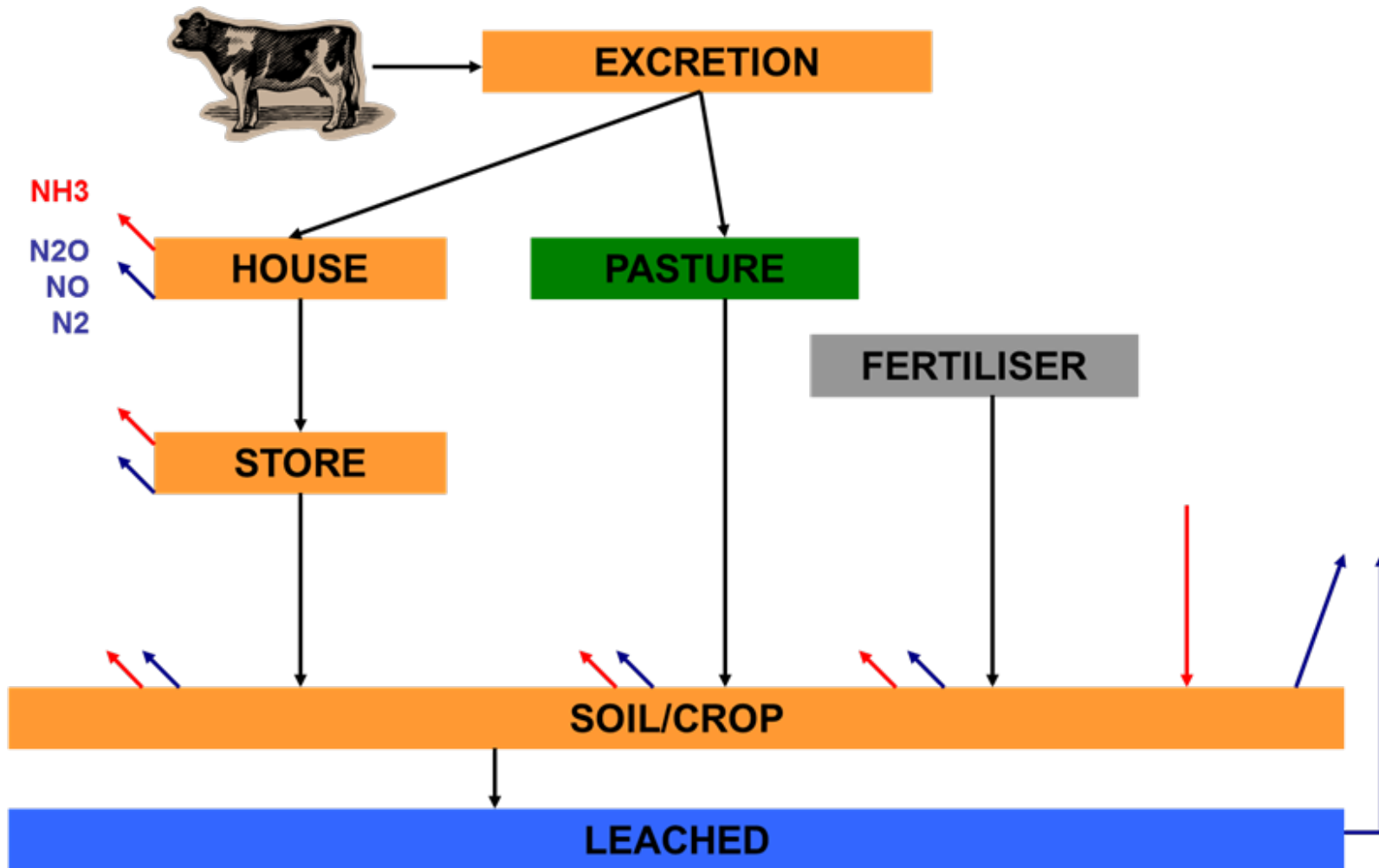
**Agriculture is major source – c. 90% for UK**

**NH<sub>3</sub> emissions from UK agriculture**

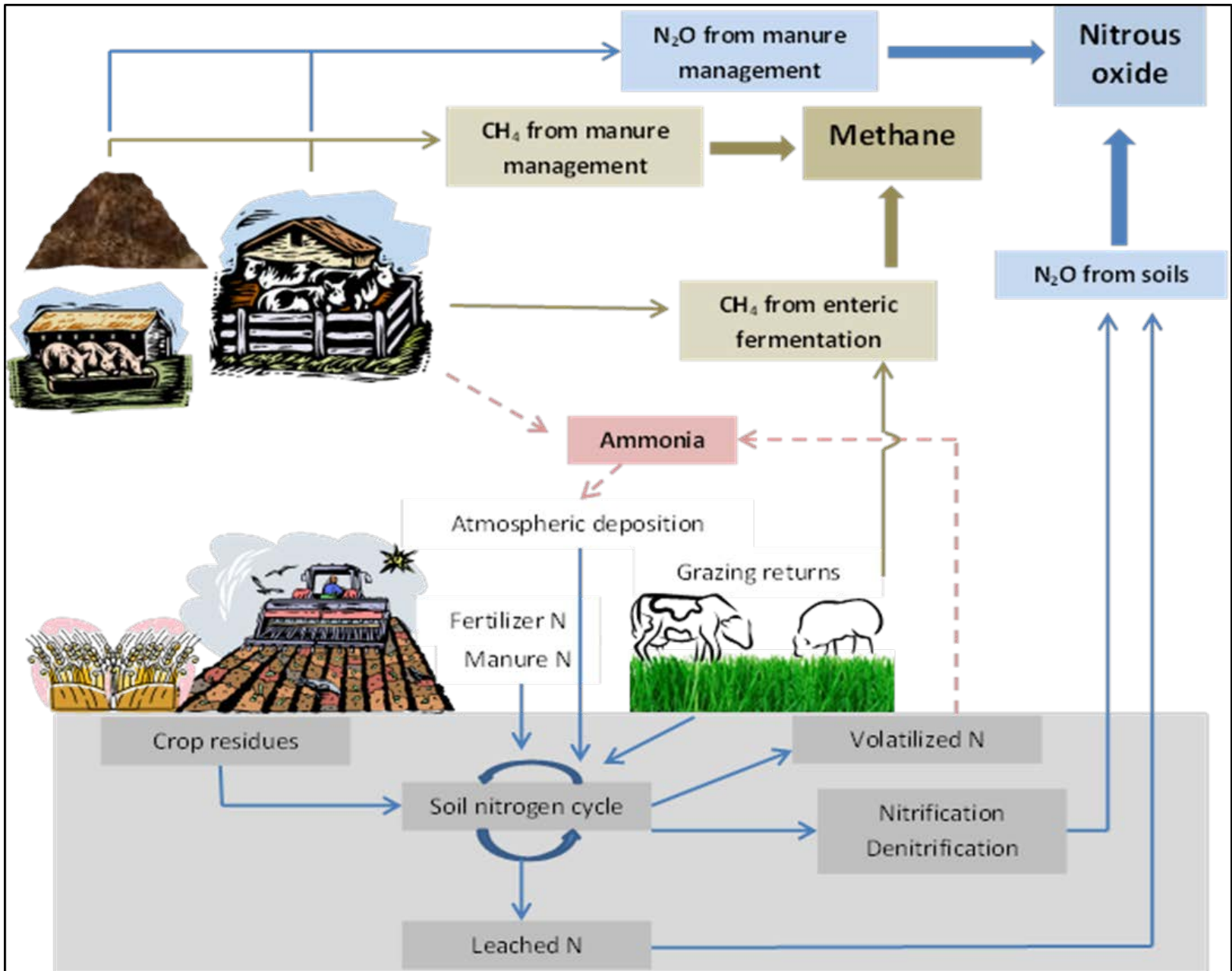


# Ammonia emission inventory for UK Agriculture

## N-flow model



# Emission inventories for UK Agriculture



- **The challenge**  
Revised NECD target...
- **The options**  
Potential mitigation measures
- **The assessment tools**  
UK inventory model  
Diffuse pollution **USER GUIDE**

MITIGATION METHODS – USER GUIDE

An Inventory of Mitigation Methods and  
Guide to their Effects on Diffuse Water  
Pollution, Greenhouse Gas Emissions and  
Ammonia Emissions from Agriculture



Newell Price, J.P., Harris, D., Taylor, M., Williams, J.R., Anthony, S.G.,  
Duethmann, D., Gooday, R.D., Lord, E.I. and Chambers, B.J. (ADAS),  
and  
Chadwick, D.R. and Misselbrook, T.H. (Rothamsted Research, North Wyke)

December 2011

Prepared as part of Defra Project WQ0106



# Potential measures – manure applications to land

## Slurry



Trailing hose



Trailing shoe



Shallow injection



## All manure types

### Rapid incorporation

- timing and method
- not for grassland or established crops

# Potential measures – manure applications to land

## *Indicative numbers*

Measure	Reduction, %	Cost, £ per tonne	Cost effectiveness, £ per kg NH <sub>3</sub> abated
Trailing hose	30	0.47	1.10-1.85
Trailing shoe	60	0.58	0.65-1.05
Shallow injection	70	0.69	0.70-1.05
Rapid incorporation - slurry	40-70	0.08-0.25	0.15-0.35
Rapid incorporation - FYM	40-70	0.16-0.34	0.45-1.30
Rapid incorporation – poultry manure	45-80	0.40-1.50	0.20-0.30

# Packages of measures – manure applications to land

## Lower efficiency measures

- **Slurry - trailing hose application to grassland and growing crops, 24h incorporation by tine where applicable;**
- **FYM/poultry manure - 24h incorporation by tine where applicable;**

## High efficiency measures

- **Slurry - shallow injection to grassland, trailing hose to arable crops, 4h incorporation by plough where applicable**
- **FYM/poultry manure - 4h incorporation by plough where applicable;**

# Packages of measures – manure applications to land

*Emission reduction, kt NH<sub>3</sub>*

Sector	2030 baseline, kt NH <sub>3</sub>	Low efficiency	High efficiency
Dairy	21.3	5.1	8.8
Beef	14.0	1.8	4.3
Pig	3.8	0.5	1.4
Layer	2.8	0.1	0.7
Other poultry	13.2	0.7	3.7
<b>TOTAL</b>	<b>55.1</b>	<b>8.2</b>	<b>18.8</b>

# Potential measures – manure storage



**Rigid tank cover**



**Floating tank/lagoon cover**



**Slurry bags**

**Sheeting cover for manure heaps**

# Potential measures – manure storage

## *Indicative numbers*

Measure	Reduction, %	Cost, £ per tonne	Cost effectiveness, £ per kg NH <sub>3</sub> abated
Rigid tank cover	80	1.58	2.30-5.50
Floating tank cover	60	0.65	1.30-3.00
Floating lagoon cover	60	0.85	0.42-0.75
Slurry bags	95	Cost-neutral*	0.00
Sheeting manure heap	60	0.63	0.80-3.35

\* At time of store replacement

# Packages of measures – manure storage

## Lower efficiency measures

- Slurry – flexible/floating covers on slurry tanks and lagoons;
- FYM/poultry manure – no measures

## High efficiency measures

- Slurry – rigid covers on slurry tanks, flexible/floating covers on lagoons;
- FYM/poultry manure – sheeting covers

# Packages of measures – manure storage and manure applications to land

*Emission reduction, kt NH<sub>3</sub>*

Sector	2030 baseline	Low efficiency	High efficiency
Dairy	33.7	7.5	12.3
Beef	24.8	2.3	7.5
Pig	7.1	1.2	2.8
Layer	3.3	0.1	1.0
Other poultry	15.3	0.7	4.6
<b>TOTAL</b>	<b>84.2</b>	<b>11.8</b>	<b>28.1</b>

# Potential measures – livestock housing



Rapid manure removal  
Manure drying  
Air cleaning



## ***Indicative numbers***

<b>Livestock</b>	<b>Measure</b>	<b>Reduction, %</b>	<b>Cost, £ per animal place</b>	<b>Cost effectiveness, £ per kg NH3 abated</b>
<b>Dairy</b>	<b>Increased scraping frequency</b>	<b>15</b>	<b>40.00</b>	<b>17.50</b>
<b>Dairy</b>	<b>Grooved floor systems*</b>	<b>35</b>	<b>20.00</b>	<b>3.80</b>
<b>Dairy</b>	<b>Washing collecting yards</b>	<b>70</b>	<b>32.50</b>	<b>5.30</b>
<b>Pig</b>	<b>Partially slatted floor*</b>	<b>30</b>	<b>6.70</b>	<b>7.40</b>
<b>Pig</b>	<b>Frequent manure removal*</b>	<b>25</b>	<b>Cost- neutral</b>	<b>0.00</b>
<b>Pig</b>	<b>Acid scrubbers*</b>	<b>80</b>	<b>10.00</b>	<b>4.20</b>
<b>Layers</b>	<b>Belt-drying</b>	<b>30</b>	<b>0.30</b>	<b>12.90</b>
<b>Layers</b>	<b>Acid scrubbers*</b>	<b>80</b>	<b>0.20</b>	<b>3.00</b>
<b>Other poultry</b>	<b>Litter drying</b>	<b>30</b>	<b>0.10</b>	<b>7.50</b>
<b>Other poultry</b>	<b>Acid scrubbers*</b>	<b>80</b>	<b>0.25</b>	<b>8.75</b>

**\* New build only – difficult to retrofit**

# Packages of measures – livestock housing

## Lower efficiency measures

- Pigs – partially slatted floor with reduced pit area
- Laying hens – air drying of manure on belts
- Other poultry – under-floor litter drying
- No measures for other livestock types

## High efficiency measures

- Dairy slurry – wash down collecting yards
- Pigs and poultry – acid scrubbers
- Dairy FYM and beef – no measures

# Packages of measures – livestock housing, manure storage and manure applications to land

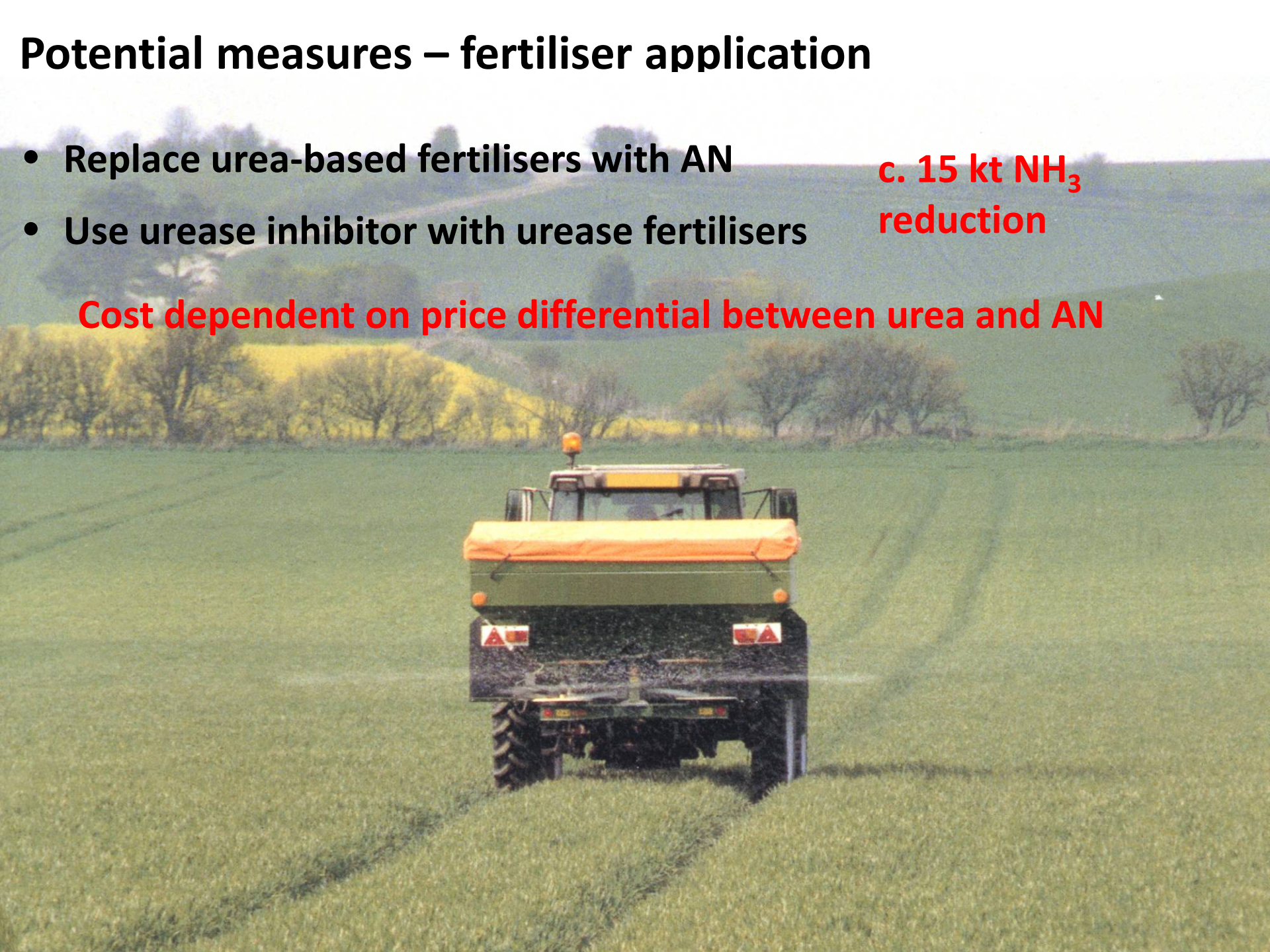
*Emission reduction, kt NH<sub>3</sub>*

Sector	2030 baseline	Low efficiency	High efficiency
Dairy	67.1	7.5	18.2
Beef	43.8	2.3	7.5
Pig	15.1	1.5	4.9
Layer	7.6	0.4	1.5
Other poultry	23.3	1.3	6.5
<b>TOTAL</b>	<b>156.9</b>	<b>13.0</b>	<b>38.5</b>

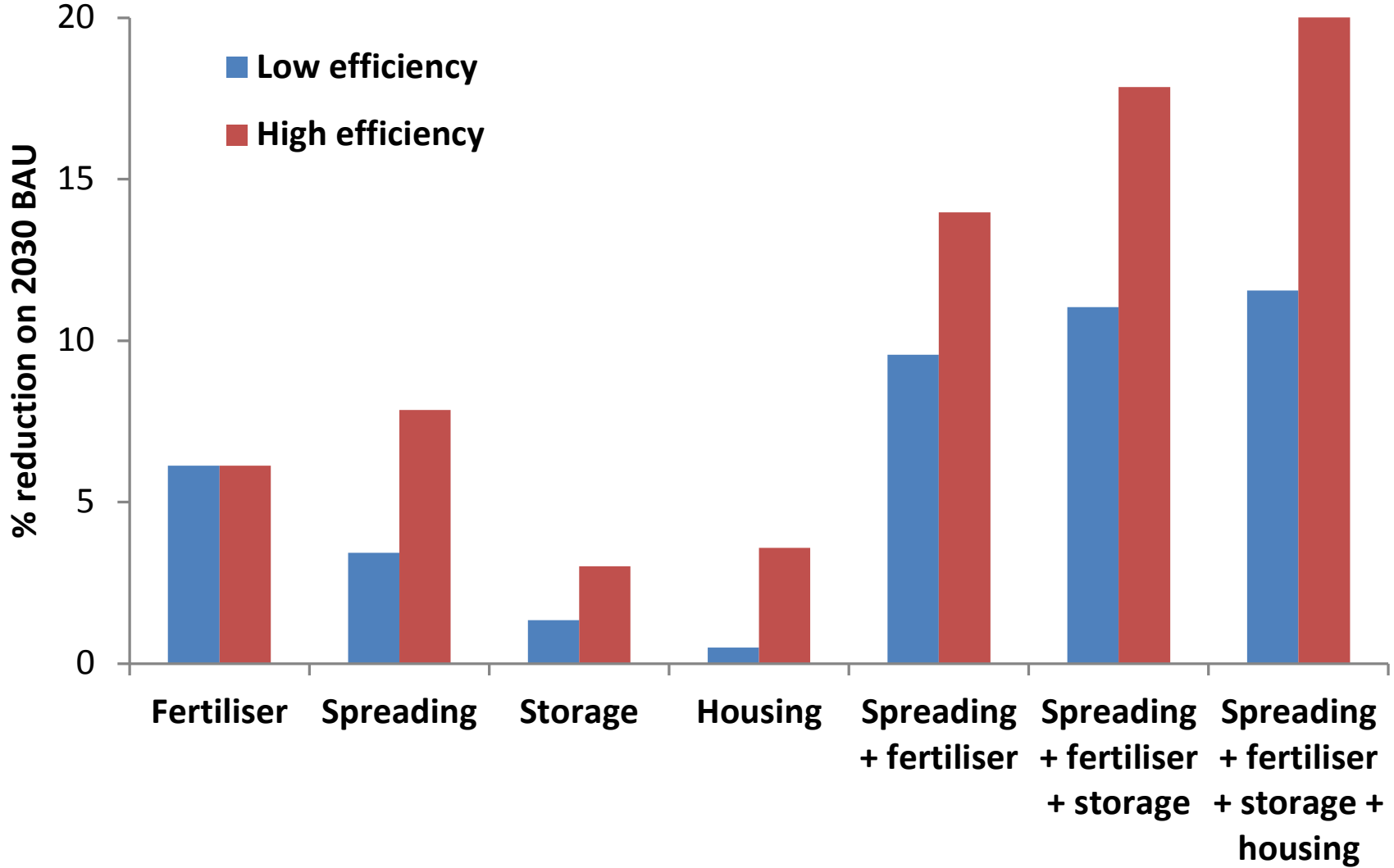
# Potential measures – fertiliser application

- Replace urea-based fertilisers with AN **c. 15 kt NH<sub>3</sub> reduction**
- Use urease inhibitor with urease fertilisers **reduction**

**Cost dependent on price differential between urea and AN**



# Summary



# Other potential measures

- **Lowering dietary protein intake – scope for dairy cows**
- **Slurry acidification**
- **Efficiency measures - improved nutrient use, health, genetic merit, etc.**

# Conclusions

- **Manure application and urea-based fertiliser**  
- largest impact, least cost
- **Manure storage**
- **Livestock housing**  
- more expensive, few options for cattle
- **Innovations and developing options**
- **Production efficiencies**

# *Questions?*

