

INTEGRATING FARMING AND WASTEWATER MANAGEMENT

– A Life Cycle Assessment of Barley  
Production using Human Urine

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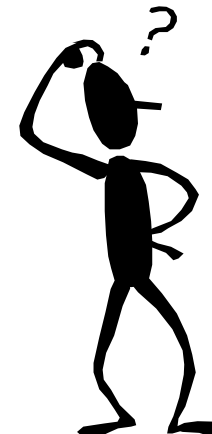
Swedish University of Agricultural Sciences



# Background

By separating urine, eutrophication from treatment plants is reduced and mineral fertilisers can be replaced, thereby reducing environmental load from the production phase of those.

However, new infrastructural investments often required.

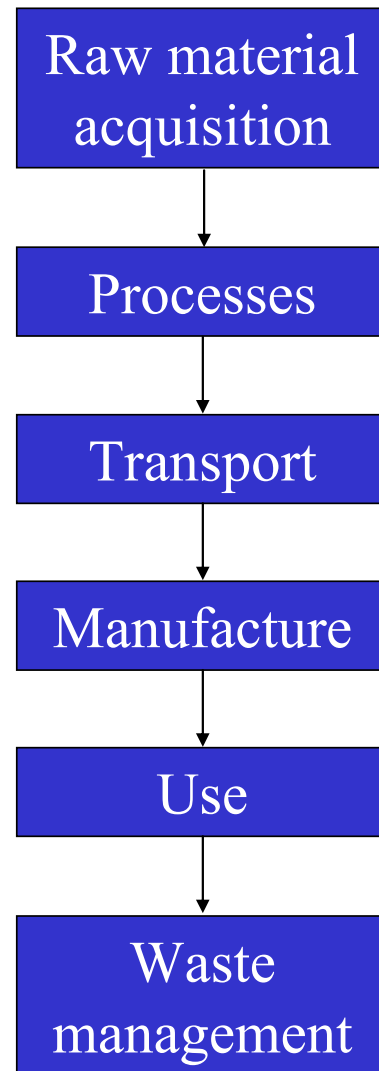


# Objectives

- Evaluating environmental consequences when human urine replaced mineral fertiliser in barley production.
- Identifying critical factors for a beneficial use of human urine as fertiliser.

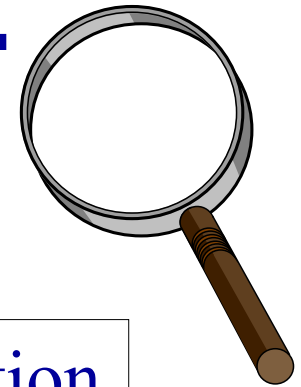


# Life Cycle Assessment (LCA)



Resource use and environmental impacts are assessed from cradle to grave.

# Data are collected... and aggregated



Inventory

Characterisation

$\text{NO}_x$

$\text{NH}_3$

P

etc.

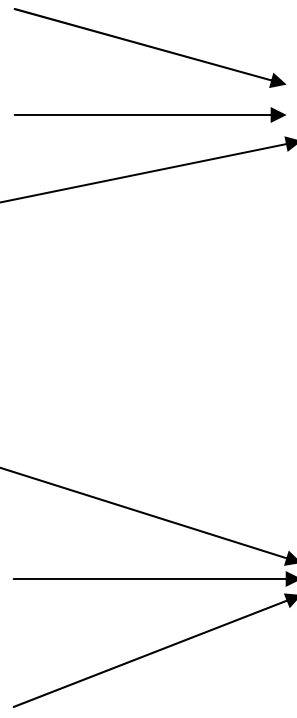
$\text{CO}_2$

$\text{CH}_4$

$\text{N}_2\text{O}$

Eutrophication

Global warming





# Assumptions

## Reference scenario:

Conventional spring barley production in the eastern part of Sweden.

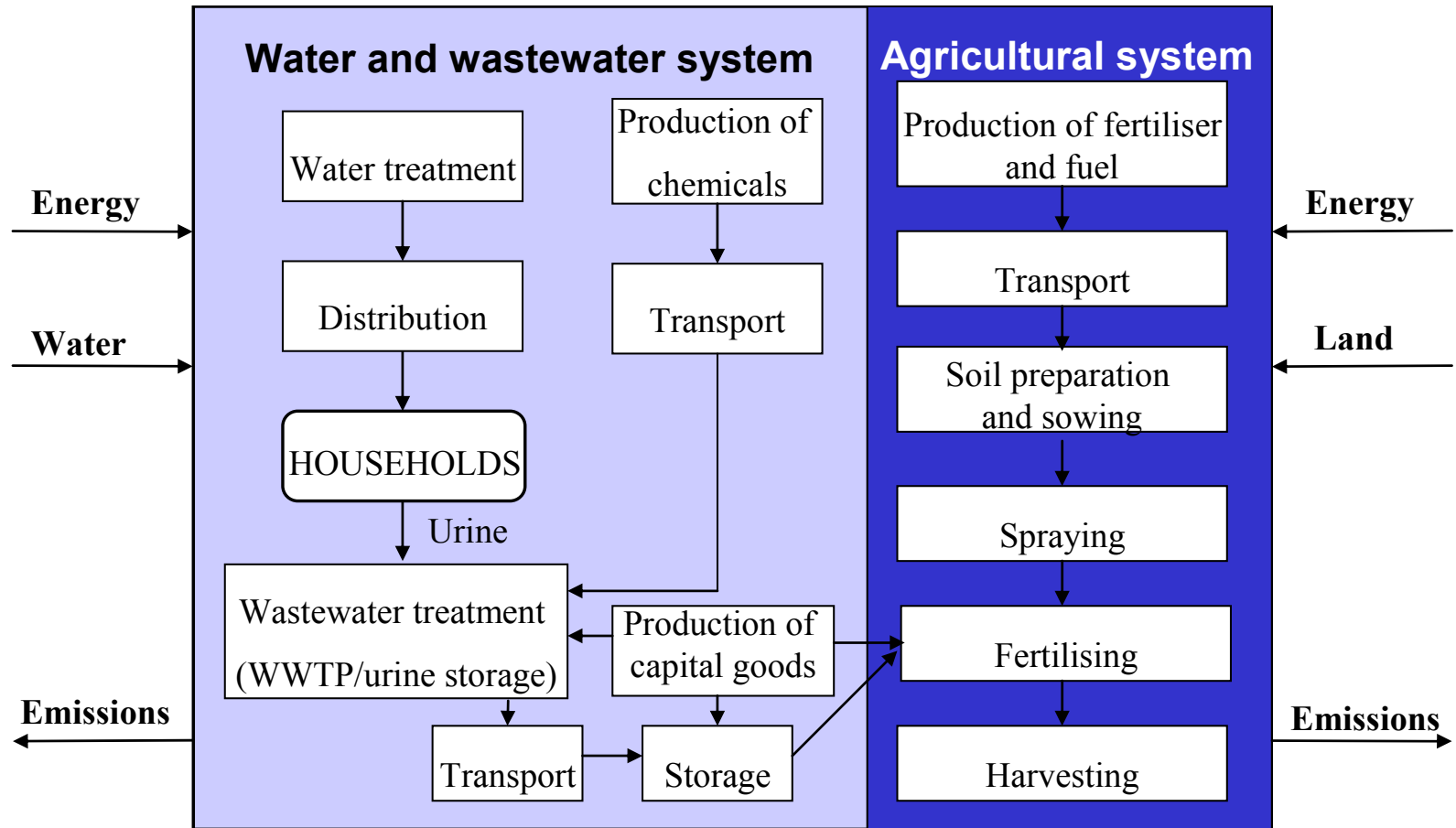
Fertilisation: 80 kg N+12 kg P. Yield: 4400 kg.

## Urine-spreading scenario:

N mineral fertiliser was replaced with  $\text{NH}_4\text{-N}$  from urine, collected from detached houses and transported 10 km.

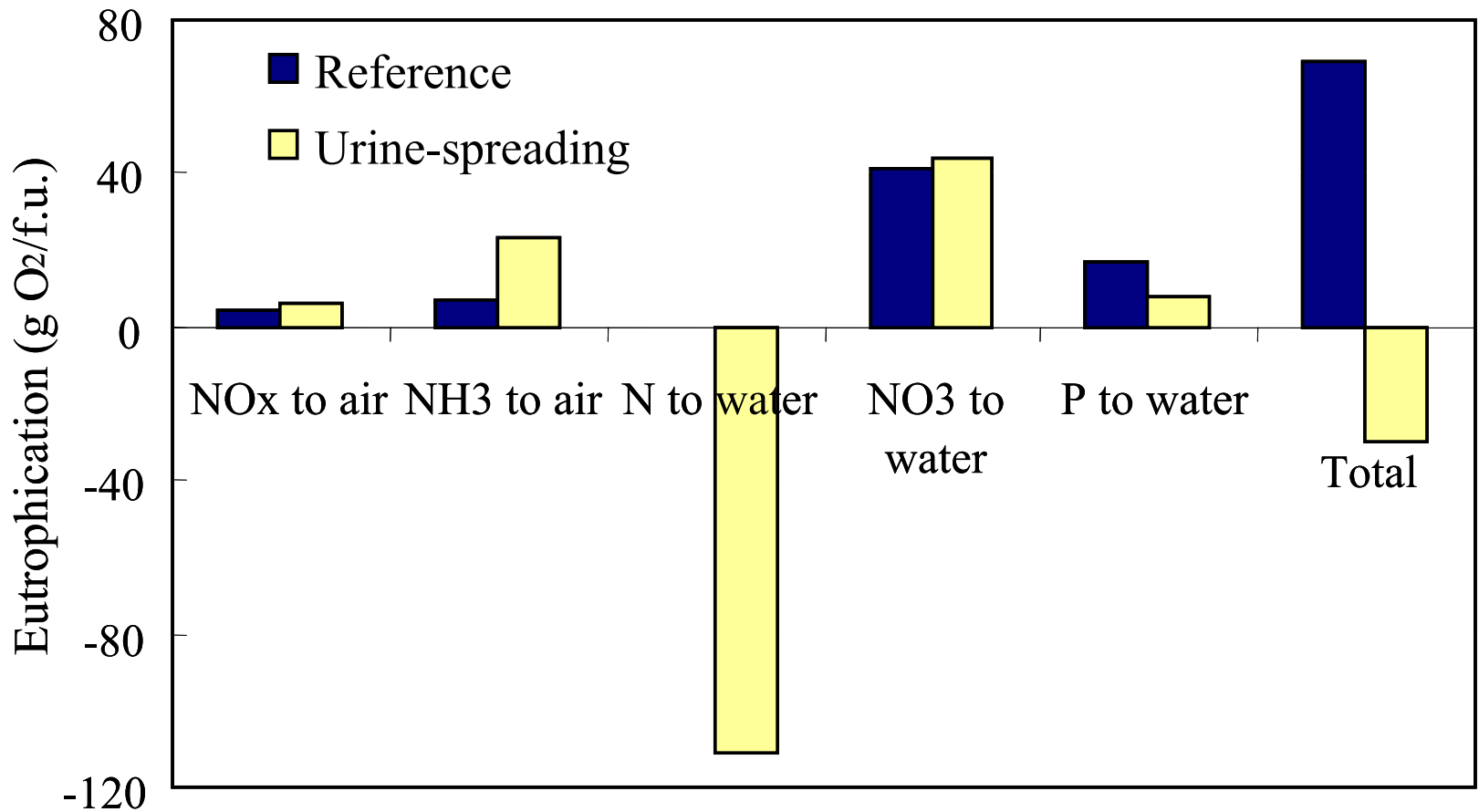
24 tonnes of urine (2.1 g  $\text{NH}_4\text{-N/l}$ ) applied per hectare.

# System boundaries



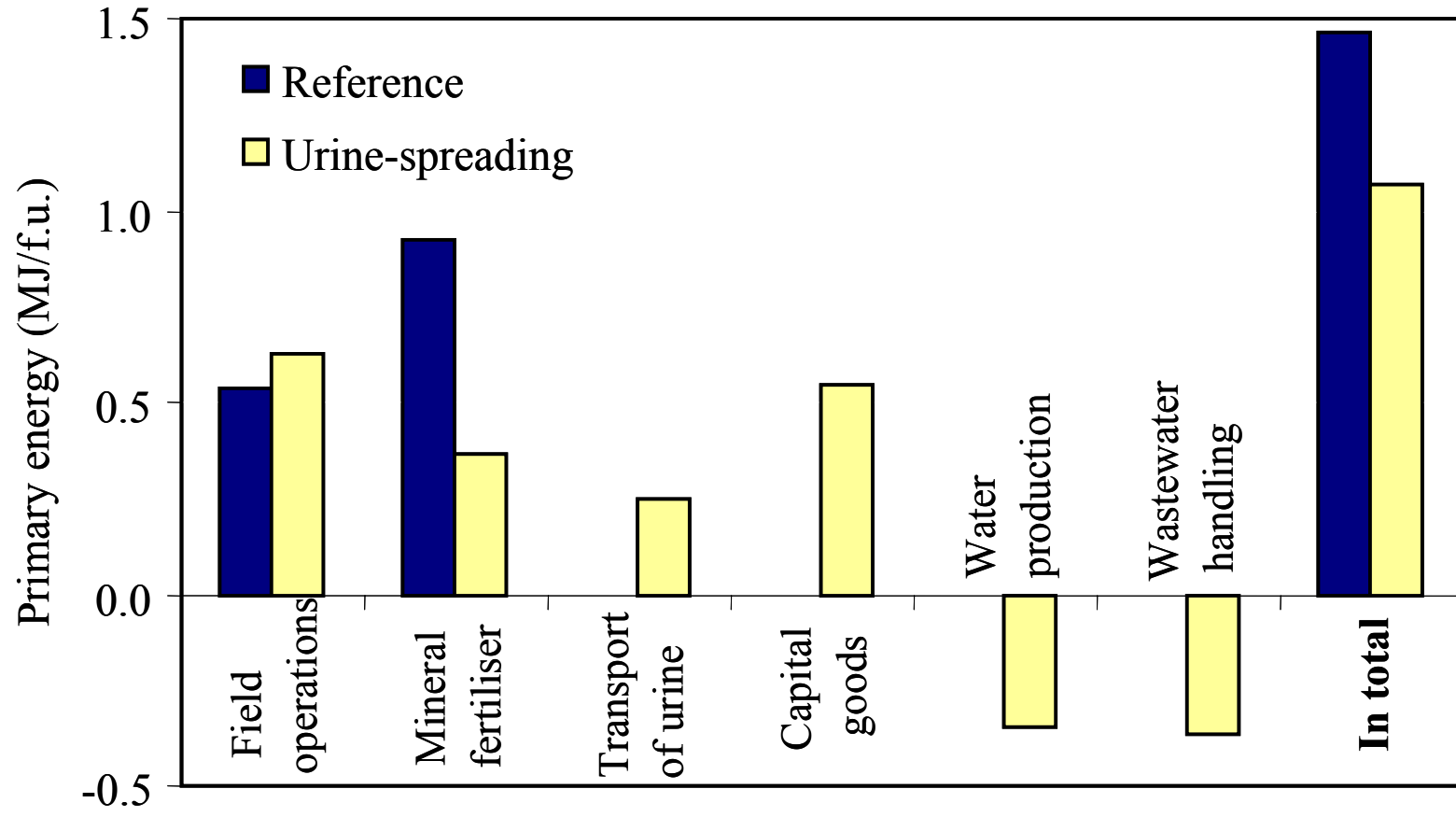
**Functional unit – 1 kg of barley**

# Eutrophication

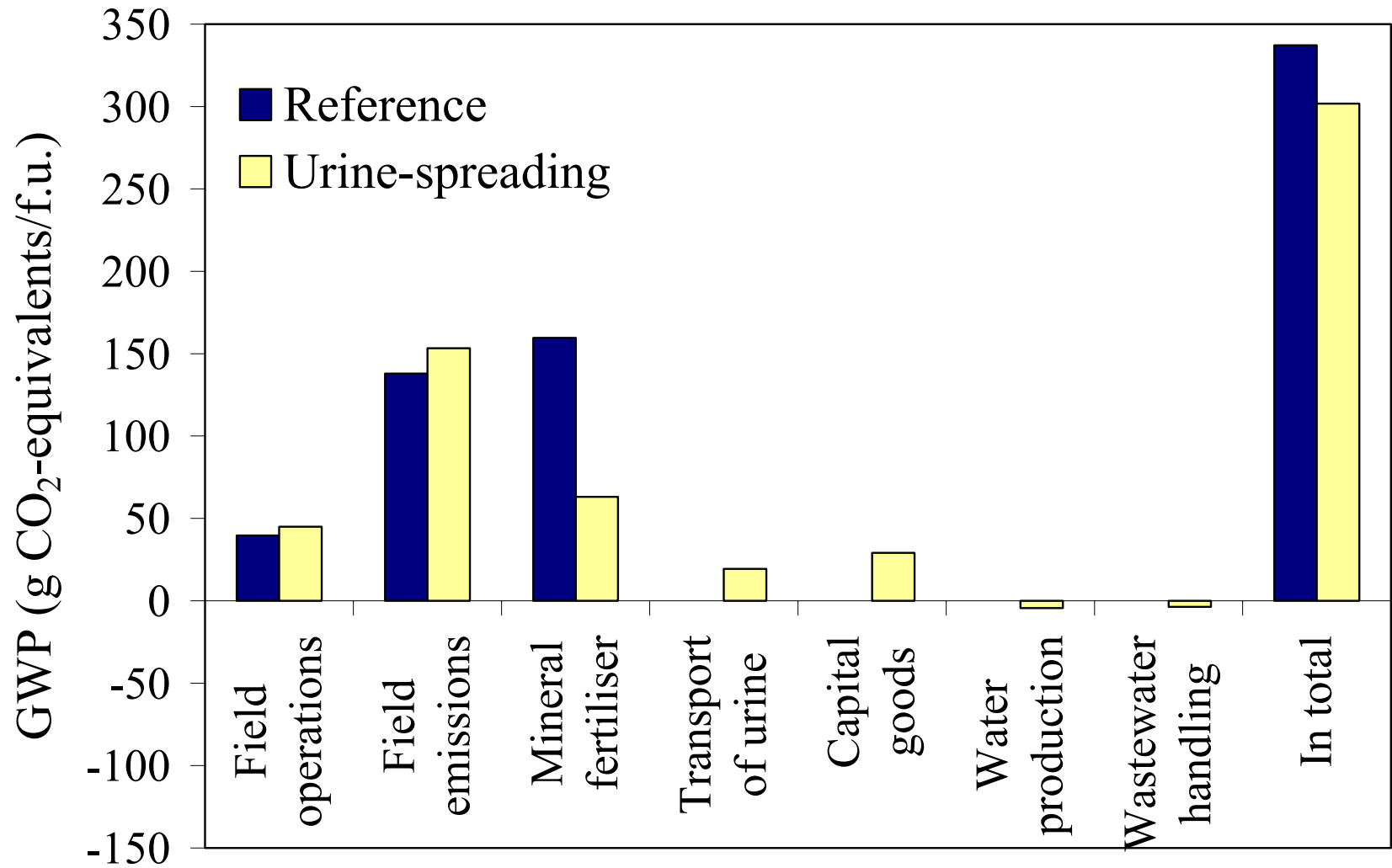




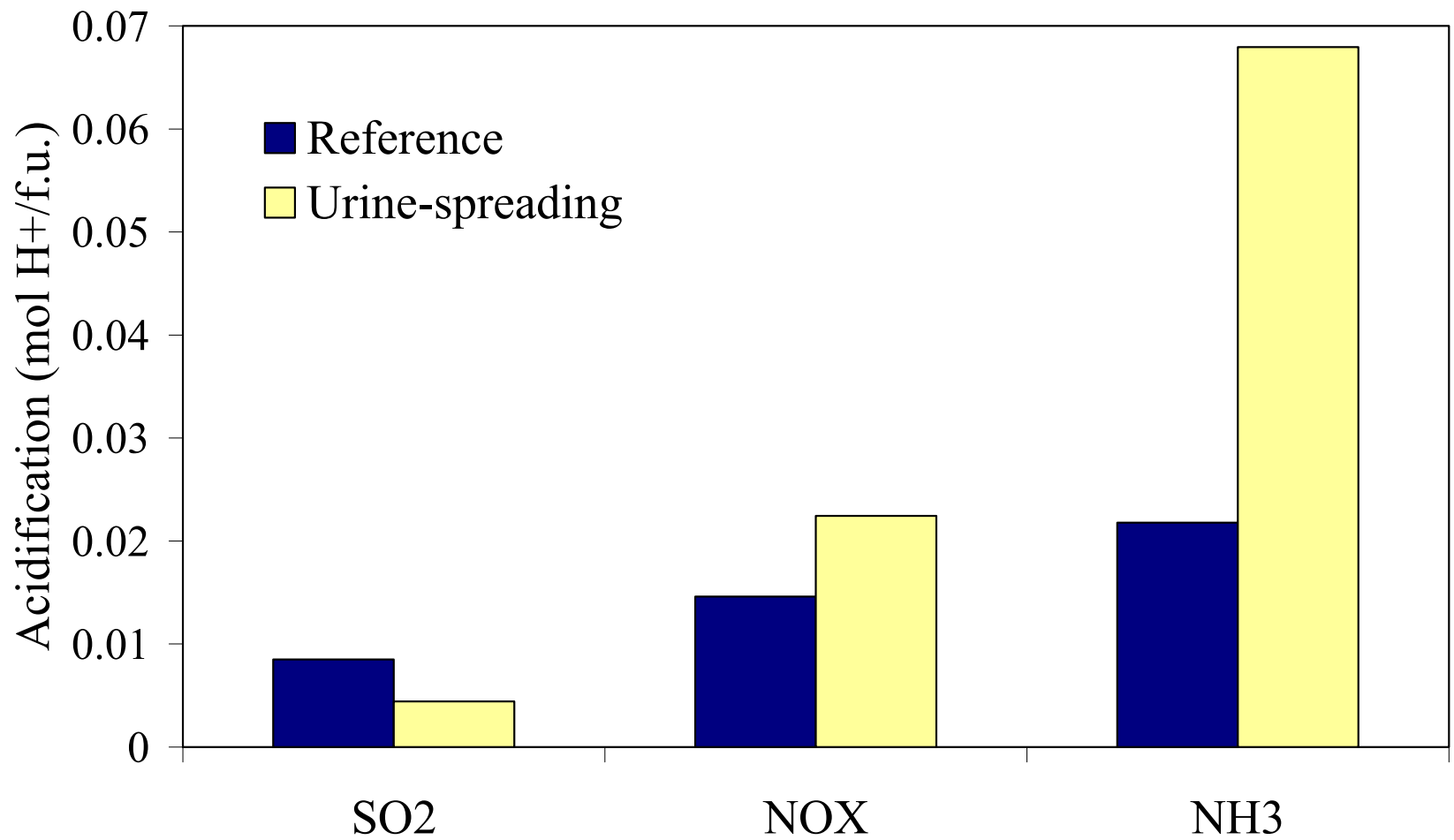
# Energy



# Global Warming Potential



# Acidification



# Normalisation

Urine from approx. 1 million users of separating toilets compared to Swedish totals (9 million inhabitants)

Emissions/use	Change (%)
GWP-gases	-0.009
NH <sub>3</sub> to air	0.3
SO <sub>2</sub> to air	-0.04
NO <sub>x</sub> to air	0.03
N to water	-0.9
P to water	-0.4
Agricultural use of N-fertiliser	-1
Agricultural use of P-fertiliser	-3
Use of electricity	-0.008



# Sensitivity analysis

- ✓ Spreading with a heavy spreader in the autumn:  
primary energy +58%.
- ✓ Urine storage in plastic tanks at household level:  
primary energy +69%.



# Conclusions

- ✓ Of special interest when eutrophication is critical.
- ✓ Several environmental benefits, *if* the system is well designed.
- ✓ Storage facilities and effects from avoided handling in treatment plant is important for use of energy.



# Conclusions

- ✓ Optimal agricultural use, i.e. substitution, spreading technique and spreading time is important for many environmental aspects.
- ✓ Planning for and evaluation of existing urine-separating systems require that the sewage handling on farm is scrutinised.



# Thank you...

The study is downloadable:

Tidåker P. 2003. Life Cycle Assessment of Grain Production using Source-Separated Human Urine and Mineral Fertiliser. Report 251.

[www.bt.slu.se/lt\\_old/publikationer.htm](http://www.bt.slu.se/lt_old/publikationer.htm)