Slurry acidification: a case study exploring the costs and benefits of slurry acidification in England

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Introduction

- The UK has committed to a 16% reduction in ammonia (NH_3) emissions by 2030.
- Agriculture is responsible for *c.* 90% of UK total NH_3 emissions.
- Slurry acidification is effective at reducing ammonia emissions at all stages of the manure management chain.

Objectives

- Quantify the impact of slurry acidification on N loss pathways - NH_3, nitrate (NO_3), and nitrous oxide (N_2O) - from pig and cattle slurry management at a national scale.
- Assess the costs (capital and operational) and benefits (societal and increased fertiliser N value) resulting from adoption of acidification technology in pig and dairy systems across England.

Image 1: In-house acidification system on a UK pig farm

Methods

- Three scenarios were modelled using a purpose-built model, based on UK greenhouse gas and NH_3 emissions inventory, and farming practises survey:
  - **1) Hypothetical maximum – all pig slurry acidified in-house, 6% and 94% of cattle slurry acidified in-house, and pre-store, respectively.**
  - **2) Maximum based on acid availability (*ca*. 50 million litres) – 87% of pig slurry acidified in-house, and 18% of cattle slurry acidified pre-store.**
  - **3) In-field only scenario based on acid availability – 87% of pig slurry, and 18% of cattle slurry acidified.**
- Changes to NH_3, NO_3 leaching, and indirect N_2O emissions costed using min, central and max costs of UK government societal benefit figures.
- Costs of installation and management of acidification systems were based on manufacturer costs for cattle – £133 cow year^{-1}.
- Costs for pig systems were derived from the installation of acidification equipment on a commercial pig farm – £41 pig place year^{-1} (Image 1).
- In-field acidification – £4.22 m^{-3} if previously broadcast, and £2.72 m^{-3} if previously band spread.

Results

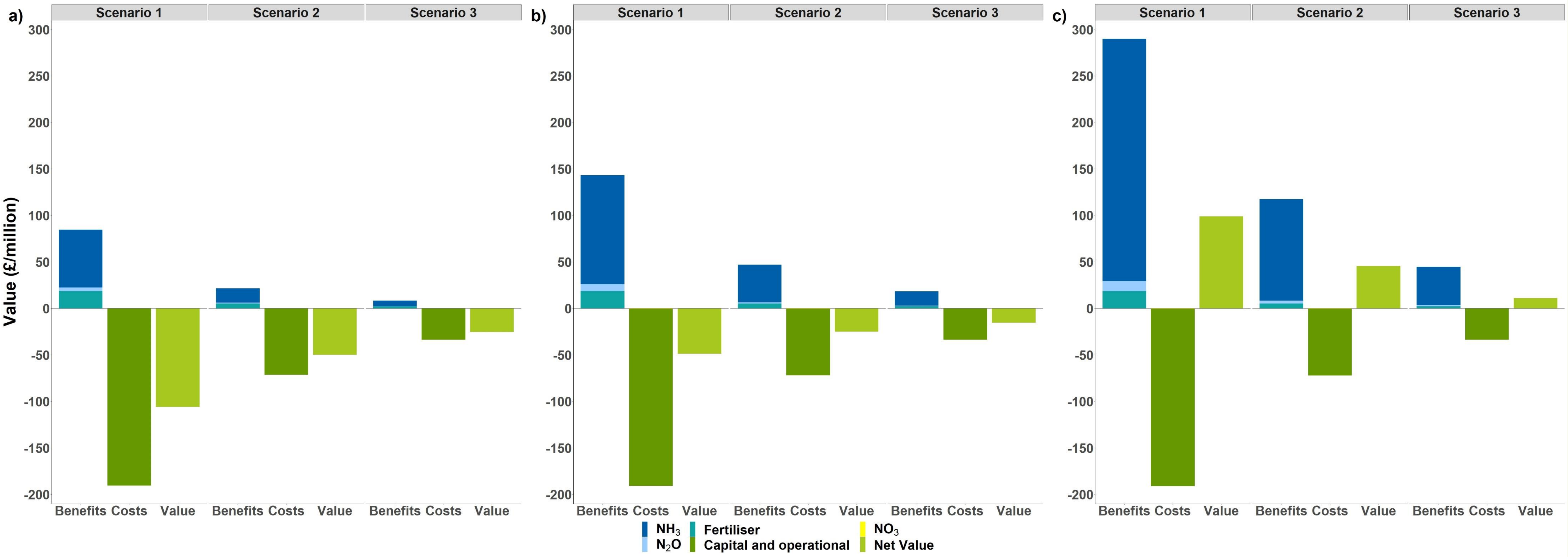

Figure 1: Cost benefits of slurry acidification across the UK. Panel a – minimum societal costs. Panel b – central societal costs. Panel c – maximum societal costs.

- The greatest NH_3-N abatement (10 kt) was achieved in Scenario 1 and delivered the greatest increase in crop available N applied (£15.7 million) but had the greatest economic cost (£190 million).
- In-house acidification was the most expensive technology but had the greatest impact on abatement potential.
- Scenario 3 had the lowest cost (£25.7 million), but also the lowest NH_3-N abatement (1.4 kt).
- The net value of implementation varied depending on the societal benefit figures used – minimum and central figures show a negative value for implementation across all scenarios, but maximum value gave a positive value for all three scenarios.

Conclusions

- All three scenarios resulted in a net deficit comparing costs and benefits for minimum (Scenario 1: -£106 million yr^{-1}; 2: -£50 million yr^{-1}; 3: -£25 million yr^{-1}) and central (Scenario 1: -£49 million yr^{-1}; 2: -£25 million yr^{-1}; 3: -£15 million yr^{-1}) cost, but a net surplus for maximum (Scenario 1: £99 million yr^{-1}; 2: £45 million yr^{-1}; 3: £11 million yr^{-1}) cost values of societal benefit on N reduction.
- The cost of slurry acidification at a national scale was predicted to exceed the benefits based on current central estimates of the societal cost of NH_3 and N_2O emissions to air and NO_3 leaching losses to water.

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