Extended Abstract
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Paper/Poster Title	**Assessing new technologies for ammonia abatement in Northern Ireland**

Abstract prepared for presentation at the 98th Annual Conference of The Agricultural Economics Society will be held at The University of Edinburgh, UK, 18th - 20th March 2024.

Abstract	***200 words max***
This paper examines ten comprehensive manure management systems that are considered viable in an NI context to reduce ammonia loss in raw milk production systems. Estimates of their ammonia loss, the cost of the system and the resulting abatement costs are developed to provide a comparison.	

Keywords	Sustainability, Slurry Management, Technology
JEL Code	Environmental Economics Q50 Environmental Economics: Technological Innovation Q55 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***
Northern Ireland (NI) is home to over 1.5 million cows and sees its beef and dairy herds as an important source of exports. It is a system defined by relatively small farms that form the core of its rural economy and agricultural system. The environmental impact, particularly excess ammonia, of such a large ruminant herd is becoming a policy priority. Various technical measures have been proposed to deal with the significant environmental costs to soil, water and air quality from excess ammonia, and there are now a range of potential technologies to deal with the problem. This paper evaluates ten manure management systems for a typical NI dairy farm, from diet to landspreading, by providing estimates of their respective annualised savings, costs and abatement costs.	

Methodology	***100 – 250 words***
An expert-led process identified ten comprehensive manure management systems that could be viable in an NI context. These were eventually split between systems with an Anaerobic Digestion (AD) component and more conventional systems. For each of these systems, and each stage within each system, ammonia loss, capital and operational costs were calculated to derive an abatement cost for the system as a whole. Ammonia loss was estimated using the National Ammonia Reduction Strategy Evaluation System (NARSES) model, informed by emission / manure characterisation data from relevant literature and relevant contractors. Capital and operational costs were derived, where possible, from contractor estimates, or	

otherwise informed by the literature. This produces an annualised abatement cost and allows for emission savings, overall cost, and abatement costs to be compared.

Results	***100 – 250 words***

The headline result is that, generally, in-house abatement systems are the most effective at reducing excess ammonia loss with around a 75% reduction in ammonia loss across the two competing technologies examined. In terms of digestate processing (i.e., AD systems), post-AD manure management technologies can remove the excess ammonia that is created through the more elaborate AD system, but at a greater cost.

Despite disparate sources to arrive at the results, the costs of in-house and in-store processing was found to be broadly similar, and so the overall abatement costs were driven by the reduction ammonia emissions. While this suggests that digestate processing may not be prohibitively expensive, the results do suggest that in-house ammonia reduction technologies are of a scale more efficient as an ammonia reduction technology.

Discussion and Conclusion	***100 – 250 words***

Overall, if ammonia reduction is a priority, in-house ammonia mitigation technologies are likely the most logical system to consider for adoption. Emerging technologies are also effective at removing the additional ammonia loss created by an AD system. The costs of such a system are comparable to a system incorporating an in-house system.

Issues surround the costs of these systems pervades, however. The range of cost estimates appear highly sensitive to macroeconomic context, and so it could be that even in-house mitigations are currently infeasibly expensive for a typical NI farm. Likewise, the fact that in-store systems (and some in-house systems) are not “off-the-shelf” and bespoke needs to be seen as a hurdle for widespread adoption.

A fundamental issue facing NI is the fact that a great many of the emerging technologies do not scale down sufficiently. In short, technologies which can be incorporated into small farms are needed if significant ammonia emission savings will be observed on farms that are typical to NI’s agricultural sector.