AN ANALYSIS OF RECENT URINE PATCH NITROGEN RESEARCH

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Introduction

The urine patch is the conduit through which the majority of nitrogen (N) is cycled in a grazed pasture system. Improving our understanding of N cycling processes in the urine patch is critical for modelling and managing N on farms. Since the early 1990s a significant amount of research has been undertaken on urine patch N dynamics including, more latterly, modelling. We have undertaken an analysis of published research on the topic to date. The aims were to identify knowledge gaps, and opportunities to improve modelling and management of N.

Approach

Findings from two literature reviews (Haynes and Williams, 1993; Selbie *et al.*, 2015) were assessed to identify trends in urine patch N research to date, and the change in state of knowledge between the two dates. In addition, the online tool Wordle™ produces a map of words occurring in the review paper text with the largest words occurring most frequently and we used it to identify the most common research topics in the paper by Selbie *et al.* (2015). A keywords search was also carried out using the Scopus research article database (www.scopus.com), using the terms 'urine', 'soil', and 'nitrogen' (14 January 2015).

Results and Discussion

In 1993, Haynes and Williams highlighted the importance of the grazing animal as central to N cycling in grazed pasture systems due to the excretion of urine and dung in patches with high N loads. The review also identified key future challenges at the time for managing grazed pasture systems, including: increasing environmental pressures, a need for more research into N leaching and nitrous oxide emissions, improved ability to model N dynamics, and a better understanding of the pathways and rates of processes within the N cycle in grazed pasture systems.

Since 1993 there has been increased focus on urine N, in particular, urine and urination characteristics, and N removal processes at the urine patch scale (Fig. 1). The majority of the published work was carried out in New Zealand, followed by the U.S.A. and U.K., respectively, and commonly in experiments using barrel lysimeters. A major driver for current research continues to be managing and mitigating N loss in order to farm within environmental limits (Selbie *et al.*, 2015). Published mitigation strategies are targeted at the soil, plant, animal and farm levels. Many of these mitigation strategies are still at the 'proof-of-concept' stage (e.g., dietary additives to reduce N excretion, diverse pasture species mixes and urease inhibitors), with few having been tested within a farm system. There have been major improvements made in N accounting using models, which are increasingly being used to estimate N losses at a range of scales (both spatially and temporally). Urine N research has targeted leaching losses, pasture uptake and nitrous oxide emissions (Fig. 2). There has been relatively less research into other N removal processes of immobilisation, and denitrification

(other than nitrous oxide). By far the majority of urine N research has been focused on dairy cows and N management and mitigation on dairy farms, rather than from sheep, beef, deer or goat farms.

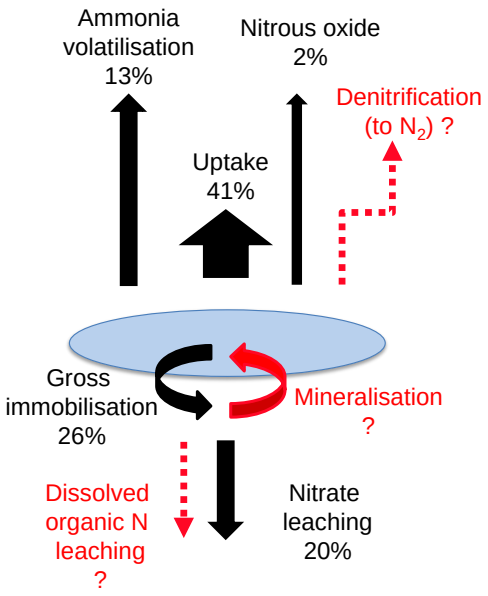

Figure 1: *State of knowledge and gaps: nitrogen removal pathways from the urine patch (adapted from Selbie et al. 2015). Values are average removal as a percentage of urine N applied. Pathways in red are poorly characterised.*

Figure 2: *State of knowledge using Wordle™ of the journal article review by Selbie et al. (2015). The larger the word, the more frequently it appears in the literature, for example leaching, pasture and nitrous oxide emissions are three of the main research areas for urine patch nitrogen research, to date.*

These findings are in broad agreement with those of Payn *et al.* (2013), who observed that much has been learnt from lysimeter studies about the fate and transport of mineral N through the soil; but also that dissolved organic N is a potentially important source of leachable N often associated with urine deposition, yet it is an under-researched topic area. They also noted that the ability to model urine patch dynamics is good but that there are still gaps in fundamental understanding of the urine patch which impacts on ability to model and manage pastoral systems: variation in urinary N composition; urine patch size, edge effects (i.e. access to urine by pasture outside of the wetted area); the effect of time and spatial distribution on N leaching. Given the importance of urine N, this is surprising.

Future research needs

Improved understanding and characterisation of denitrification, dissolved organic N leaching and immobilisation will help to tighten the loop of N cycling within grazed pasture systems and improve our modelled estimates of environmentally important losses of N (e.g., leaching and nitrous oxide emissions). The main challenges ahead for modelling N in grazed pasture systems are: scaling up from urine patch to paddock and farm scale, and understanding the sensitivity of modelled estimates to highly variable urine patch characteristics. Future research should consider N management in systems other than dairy only. Improved management and mitigation of N in urine patches is on-going, however many mitigation strategies, still at the proof-of-concept stage, need to be evaluated within a farm system context.

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