Guidance Document on NUE indicators of the global project INMS

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Abstract

The Guidance Document on NUE indicators has been written in the context of the global project INMS. The Guidance Document, signed by 46 specialists from 19 countries, comprises six sections and 18 chapters covering those aspects considered critical to review, harmonise and update the knowledge on NUE to be used beyond by scientists, practitioners, and policymakers. This document critically analyses different definitions, methods, approaches, considerations, unconventional aspects, exceptions, and uncertainties concerning NUE indicators.

Keywords: Nitrogen use efficiency, system boundaries, cropping systems, livestock systems, full chain NUE

1. Introduction

Directing the highest proportion of N injected into agricultural systems to food rather than to the environment is paramount. The nitrogen use efficiency (NUE) indicator deals with this challenge and can be generally defined as the proportion of the N inputs that is retained in agricultural outputs. This simple and widely used parameter is still a major misunderstanding source (Zhang et al., 2021). As is analysed throughout this Guidance Document, there are many different definitions, systems, scales and approaches that should be well known in order to precisely understand what we mean when we talk about NUE. This INMS Guidance will contribute to reducing imprecise use of the term while encouraging harmonisation and comparability

2. Methods

The writing of this GD was launched in the INMS joint workshop, NUE indicators for Demo Regions, Modelling and Barriers Assessment, which took place in Madrid (18–22 November 2019) in Task 1.1.3, supported by Tasks 1.6 and 2.4. Thirty-eight researchers from 17 countries attended the meeting. The attendees included NUE experts, INMS Demonstration Site representatives (eight Demo Sites) and contributors to the Modelling component and Barriers activities. Specialists of different NUE approaches were then invited to contribute to the diverse sections.

3. The Guidance Document

This Guidance Document, signed by 46 specialists from 19 countries, comprises six sections and 18 chapters covering those aspects that we consider critical to harmonise the knowledge on NUE in the context of the global INMS project, to be used beyond the project by scientists, practitioners, and policymakers.

The document begins with the definition of the boundaries (Fig. 1) and standard inputs and outputs for cropping, livestock (animal nutrition), farm and agro-food systems (Billen et la. 2014, Zhang et al., 2020). Ways to estimate NUE in each system are also defined.

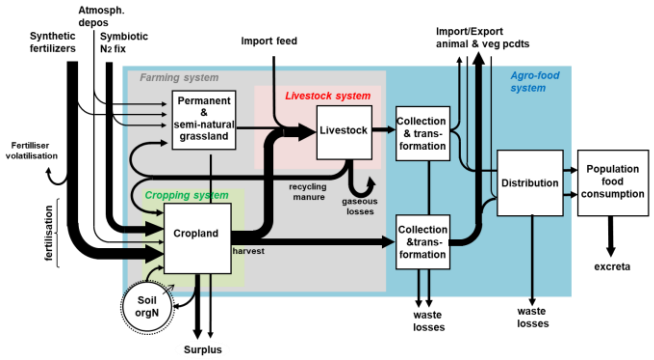

Fig. 1. Diagramme of agro-food systems in terms of N fluxes, processes and storage. Delimitation of four sub-systems for NUE estimations.

A section on cropping systems includes the analysis of the strengths, limitations and applicability of the most common methods for determining NUE in crops. The uncertainty associated with the quantification methods, the influence of non-considering some missing inputs and the importance of covering complete rotations are discussed. Three chapters study the singularity of NUE estimation in low-N-output systems, those where N fixation represents the main N input and agro-forestry systems. Interactions with water and phosphorus use efficiencies are finally discussed.

The section on livestock systems describes different approaches to estimate NUE. The effect of scale, as well as the externalisation of impacts associated with feed production and manure export, are analysed. An approach to estimate the full-chain NUE is described. This is the first step to undertake the challenge of halving N waste in the coming years (Sutton et al., 2021). The incorporation of NUE into Integrated Assessment Models as a key parameter to develop scenarios is undertaken.

A final section includes four chapters investigating alternative ways to improve NUE for different systems and scales. The first chapter of this section reviews strategies for improving NUE in cropping systems under the umbrella of the 4R concept. NUE of livestock systems could be enhanced following different strategies in feed production, manure management, animal husbandry and feeding composition levels. The effect of climate change on NUE is highlighted. Finally, the capacity of structural transformations is studied, including human diet, excreta and urban sewage, and actions dealing with the organisation of the farming system, including crop and livestock management and their reconnection.

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