COST-EFFECTIVE MITIGATION OF AMMONIA EMISSIONS FROM FERTILIZER USE IN SPANISH AGRO-ECOSYSTEMS

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1. Introduction

Agriculture is the main sector responsible for ammonia (NH_3) emission to the atmosphere, accounting for c. 94% of the total emission in 2011 (EEA, 2014). Of this, nitrogen (N) fertilization accounts for c. 35% of NH_3 volatilization. These losses and subsequent deposition, together with associated increase in particulate matter concentrations, are of environmental and socioeconomic concern. A significant abatement effort has been made in the last 20 years in some EU countries (Bittman et al., 2014). Unfortunately this has not been the case in Spain were NH_3 emissions increased by14% in the 1990-2011 period, situating the country in the last place in terms of target achievement (EEA, 2014). Due to the recent revision of the UNECE Gothenburg protocol, the targets are now much more restrictive, with requirement for Spain to achieve a NH_3 reduction of 10% by 2020. Further more ambitious requirements (i.e. up to 30%) might be expected for 2030. Mitigation strategies for emissions from fertilizer use focus on: 1) the type of fertilizer applied (e.g. urea (U) *vs* organic fertilizers or other synthetic fertilizer); 2) the method of fertilizer application (i.e. incorporation into soil); and 3) the use of additives to modify soil processes leading to NH_3 volatilization (e.g. urease inhibitors) (Bittman et al., 2014). The objective of the present work is to assess the cost-effectiveness of these strategies as a basis to develop achievable mitigation scenarios.

2. Materials and methods

We firstly developed a baseline-scenario representing the current situation of the country in terms of N application rates to agro-ecosystems. Secondly, emission maps (EM) were produced using CORINAIR emission factors (EFs). Abatement EFs and scenarios of application were used to construct abatement EM. Then, to relate the abating effect of each measure with their cost of implementing, a cost-benefit analysis was carried out by considering the cost of implementing the mitigation and the revenue of the potential increase in crop yield associated to that implementation. Different scenarios of mitigation were finally proposed based on the previous analysis. The technical mitigation strategies evaluated were: (i) U management (i.e. incorporation, washing and urease inhibitors), (ii) U substitution by a different synthetic/organic N source, (iii) better distribution of slurries to avoid U inputs, (iv) improved slurry application (e.g. trailing shoe). The scale of the study was sub-regional (provinces; NUTS3 in Eurostat). The main sources of information on N fertilizers are shown in Table 1. The calculation of N excess in each province was estimated as a preliminary step for the development of the baseline-scenario. For this calculation, information on N crop harvested, N in the straw harvested and biologically fixed N was used as external N needed by the crop under optimal conditions. This was subtracted to the total N applied in agricultural soils. Also, aiming to calculate the excess of organic N to be relocated; only organic N from animal systems was considered. The main crops cultivated in Spain, in terms of surface and productivity, were included in the analysis.

N pool	Information source
Urea-N application	Balance del nitrógeno en la agricultura española (2008)
Organic N from animal sources	National GHG Inventory Report 2013
N harvested by crop	Year book of N statistics (N contents Lassaletta et al. 2014)
N straw	Year book of N statistics
N biologically fixed	Calculated following Lassaletta et al. (2014)
N in composted urban wastes	Balance del nitrógeno en la agricultura española (2012); National GHG Inventory Report 2013
N in composted sewage sludge	Balance del nitrógeno en la agricultura española (2012)); National GHG Inventory Report 2013

3. Results and Discussion

Urea application in Spain is heterogenous (Figure 1a), requiring a different implementation of technical strategies between provinces. Knowing the location and application rate of U facilitates the assessment of the effectiveness of mitigation options over volatilized NH_3.

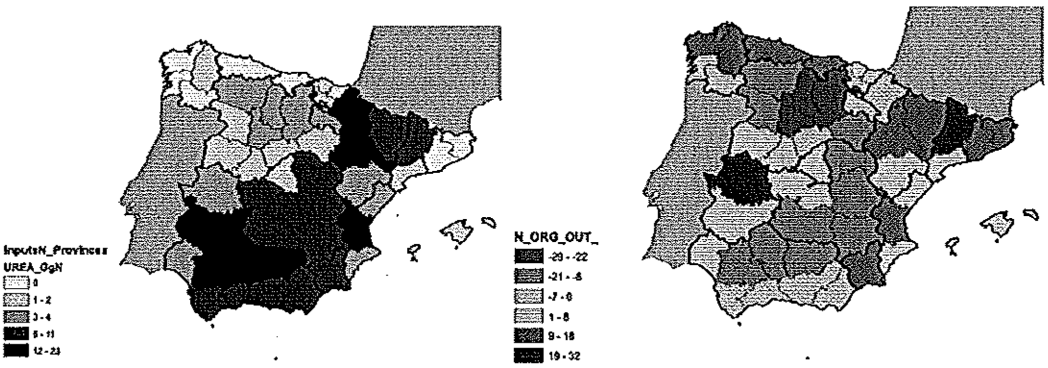

Fig. 1. a) Urea-N application rate (GgN/yr) and b) excess of organic-N applied (GgN/yr) at sub-regional (province) scale for the present years.

The N application-baseline scenario showed that there is an excess of organic N applied in certain provinces with high concentration of animals (Figure 1b). This picture could be the starting point for policies inclined to the recirculation of animal wastes when possible, from N exceeding areas to poorly N ones, also taking into account applicability and costs associated to transport of animal wastes. Other structural changes (e.g. a policy of livestock redistribution) aiming to increase the N efficiency of the entire Spanish agro-food sector are matter of discussion within this research initiative.

4. References

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