

IDENTIFICATION AND SELECTION OF AN ENVIRONMENTAL INDICATORS SET FROM A REACTIVE NITROGEN FLOW ANALYSIS FRAMEWORK

J. Soler-Rovira¹, P. Soler-Rovira², J.M. Arroyo-Sanz¹

¹ *Dep. of Agronomy, Madrid Technical University, jose.soler@upm.es; juanmanuel.arroyo@upm.es*

² *Institute for Agricultural Sciences, Centre for Environmental Sciences, C.S.I.C., pedro.soler@ccma.csic.es*

Introduction

Reactive nitrogen loads causes important impacts on the environment (Soler-Rovira et al., 2008) so its flows and key sources and drivers knowledge are essential for developing management and policy options (De Clercq et al., 2001). The use of environmental indicators will help to understand a complex issue and facilitate decision making (EEA, 2005). The aim of this work is to apply a previous N flow analysis as a framework for the identification and selection of a set of environmental indicators pertaining to reactive N in the Spanish agricultural and food production sector.

Materials and Methods

Data from a previously calculated N flow analysis in the agri-food system of Spain in the period 1996-2000 have been used (Soler-Rovira et al., 2006). This was the framework to identify the key driving forces and to make an initial selection of the indicators. Several statistical databases have been used to calculate these indicators. Some of them were computed by modelling: N excretion of livestock (as described in Sheldrick et al., 2003) and N fixation of legume crops (as Soler-Rovira et al., 2006). Total anthropogenic N inputs were calculated as: ammonia imports + fertilizers imports + ammonia fixation + feed and food imports + N in fish products + legume crops biological fixation + NO_x emissions. These indicators were analyzed under several criteria (Tab. 2) as indicated in EEA (2005). Each of these criteria was computed as low (*), medium (**), or high (***). The final score was evaluated as: useful (***), potentially useful (**) and low potential (*).

Results

The initial set of selected indicators included 36 variables (Tab. 1) and the evaluation of some of them is shown in Tab. 2.

Tab. 1. General categories and environmental indicators considered in the study

Category	Indicators			
Fertilizers	Production		Consumption	Imports Net imports
Agricultural products	Production		Food production	Feed production
	Imports	Net imports	Soil N balance	Fixation legumes
Livestock	Number		Products	N excretion
	Cattle	Pigs	Meat	Cattle Pigs
	Sheep+goats		Eggs	Sheep+goats
	Poultry		Milk	Poultry
Consumption	Total dietary protein		Total dietary energy	Total dietary fat
	Protein animal products		Energy animal products	Fat animal products
General	Atmospheric emissions and deposition			Anthropogenic inputs

According to the evaluation criteria used, fertilizer and feed production, livestock number and dietary proteins of animal products were considered as useful indicators. However, the N

atmospheric emissions can only be considered potentially useful because, although they showed high scores in cost effectiveness criterion, they obtained a medium evaluation in the other since this indicator is not based in direct measurements or time series are not available. Anthropogenic N inputs had a low potential because it should be difficult to understand, especially for non-specialist end-users; additionally there are not some available data that must be calculated. The temporal trend (1961-2002) of these indicators was studied in order to know in which direction was going the system (Fig. 1). A great increment was observed in all the indicators: while some doubled the reference value of 1961, some others (i.e. fertilizer production and net imports of agricultural products) were multiplied by 5. These observations indicate that anthropogenic N inputs in Spain have been increased by a factor of 4.

Tab. 2. Evaluation of some selected environmental indicators: Feed production⁽¹⁾; Fertilizer production⁽²⁾; Number of pigs⁽³⁾; N emissions⁽⁴⁾; Anthropogenic N inputs⁽⁵⁾; Dietary protein of animal products⁽⁶⁾.

	FP ⁽¹⁾	FerP ⁽²⁾	NP ⁽³⁾	Ne ⁽⁴⁾	ANI ⁽⁵⁾	DPAP ⁽⁶⁾
Responsiveness	***	***	***	**	***	***
Analytical soundness	***	***	***	**	*	**
Data availability	**	**	***	**	*	***
Ease of interpretation	***	***	***	**	*	**
Cost effectiveness	***	***	***	***	*	***
Total score	***	***	***	**	*	***

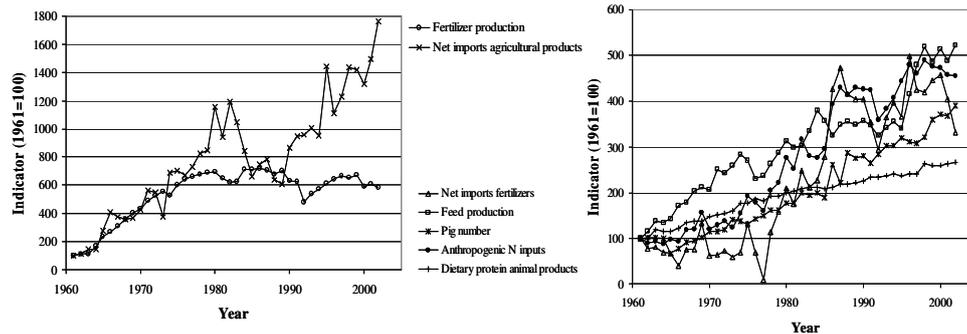


Fig. 1. Temporal trend of some environmental indicators relating to reactive nitrogen in Spain (1961-2002).

Conclusions

Thirty six indicators for were selected and evaluated, and some showed high potential usefulness. Their temporal trend showed a large increment since 1961, indicating that anthropogenic N inputs increased. This framework will allow the evaluation of management strategies and will help to develop an integrated N policy in the near future, improving N use efficiency and agronomic management, and also sustainable and healthful diets.

References

- De Clercq, P. et al. 2001. Nutrient management legislation in European countries. Department of Soil Management and Soil Care, Ghent University, 347 pp.
- EEA. 2005. Agriculture and environment in EU-15-the IRENA indicator report. European Environment Agency, Copenhagen, 128 pp.
- Sheldrick, W. et al. 2003. Contribution of livestock excreta to nutrient balances. Nutrient Cycling in Agroecosystems, 66: 119-131.
- Soler-Rovira, J. et al. 2006. Nitrogen flow analysis in the Spanish agricultural and food production system. In: Schroder, J.J., Neeteson, J.J. (eds). N management in agrosystems in relation to the Water Framework Directive. Plant Research International, Wageningen Report 116: 36-39.
- Soler-Rovira, J. et al. 2008. Environmental impact assessment of reactive nitrogen in the Spanish agri-food sector. 6th International Conference on LCA in the Agri-food Sector, Zurich, November 12-14.