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Development of a software to calculate pollutant emissions, resources consumption and best available techniques effects on emission and consumptions from Spanish farms

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ABSTRACT

This paper describes the development of a software tool supported and coordinated by the Spanish Ministry of the Environment and Rural and Marine Affairs, whose objective consists in calculating the pollutant emissions into the air, as well as water and energy consumption from Spanish pig and poultry farms. Furthermore, this new tool will give farmers the chance to know the effects of best available techniques (BAT) on emissions and consumption levels in order to improve the environmental situation on their farms.

OBJECTIVE

The objective of this paper is to describe the development of a software tool, designed with the aim of:

- Calculating ammonia, methane and nitrous oxide emissions from a particular farm, in comparison to the reference system (before the implementation of BAT on the farm).
- Calculating water and energy consumption from a particular farm, in comparison to the reference system (a farm using standard practices).
- Understanding in a better way the BAT and their influence over pollutant emissions, and over water and energy consumption.

MATERIALS AND METHODS

The structure of this new software tool requires all the information related to the farm that may have an effect on pollutant emissions or resources consumption from Spanish pig and poultry farms. Seven screens should be filled, including information about:

1. Farm location: name, address, location (village and county) and administrative classification (production pigs, on site farm ...).

2. Animal census: highest productive capacity, up to date animal numbers, annual production.
3. Facilities design: for each animal type, describe facilities design: floor, pit, slurry or manure remove frequency, material used for bedding.
4. Slurry and manure storage system: description of storage for solid and litter-based manure, slurry tanks and earth-banked stores or lagoons.
5. Slurry and manure management: ratio of on-farm manure management or external treatment system.
6. Slurry and manure application to land: crop, surface spreading, slurry or manure application systems (splash plate, band spreader, injector or incorporation) and application time.
7. Consumption of water and energy: implementation of techniques so as to ensure the efficient use of water or energy, as equipments with high-pressure cleaners, drinking systems, low consumption lights.

The database used to obtain the emission calculations was the same as that used in the National Emission Inventory (2003). For water and energy consumption, a huge bibliography review was carried out. Information regarding manure production was obtained from the Spanish legislation (RD 324/2000).

To calculate pollutant emission in each stage of the productive process, the software uses a mass-balance system, including the reduction ratios obtained from experimental trials carried out by MAPA in an environmental project conducted through 2003-2007.

RESULTS

The results obtained with this software are:

- Slurry or manure storage capacity in months. The storage capacity measured in months in accordance with animal number, animal type, facilities design and storage facilities dimensions can be calculated.
- Slurry or manure composition and production. Slurry or manure production can be calculated, expressed in cubic meters, and the percentage of total nitrogen, depending on animal numbers, animal type, facilities design, feeding system and storage system.
- Nitrogen balance. In the screen for slurry and manure application to land, crop nitrogen requirements, nitrogen applied with the fertilization program and nitrogen balance can be calculated. Slurry and manure composition, application system, crop type and crop production, effects on the balance.
- Ammonia, methane and nitrous oxide emissions (Figure 1). Animal number, animal type, facilities design, storage system and application system affect to these emissions.

Figure 1. Screen shot showing the estimated gaseous emissions

Gas emissions

Emission results

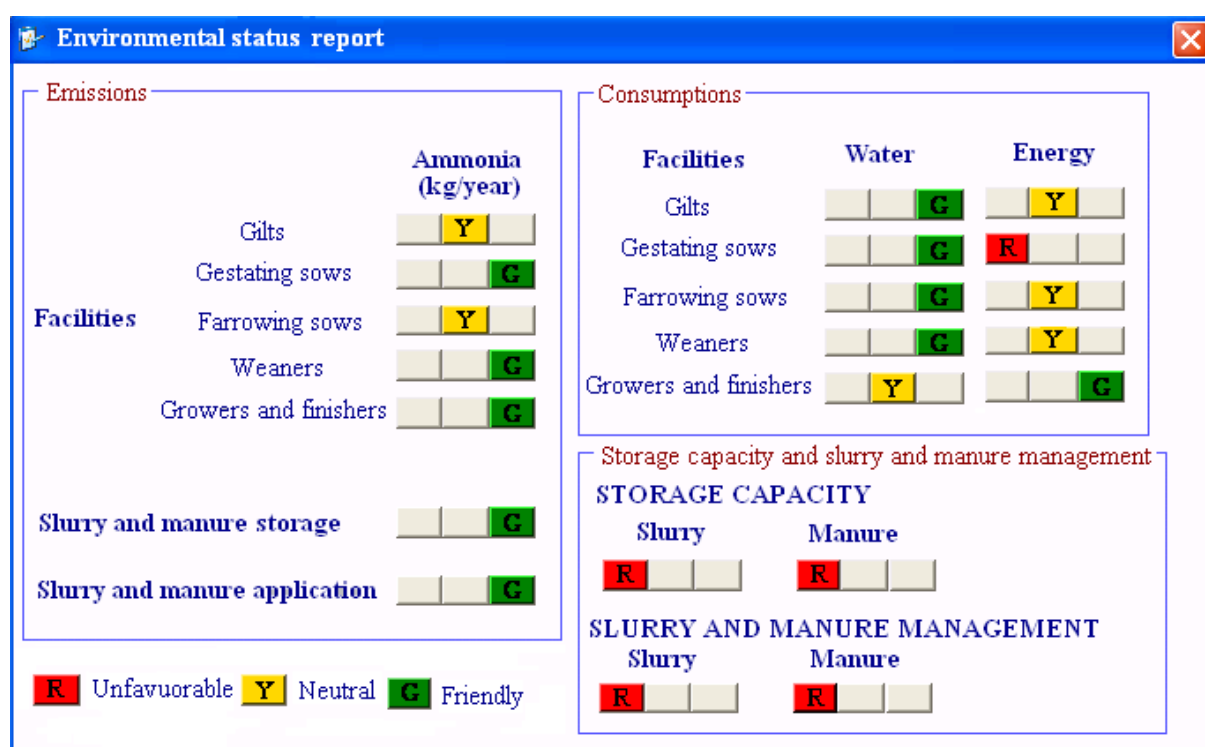
		Ammonia (kg/year)		Nitrous oxide (kg/year)		Methane (kg/year)	
Facilities	Gilts	518	518	0%		169	
	Gestating sows	4134	6335	-34.7%		2494	
	Farrowing sows	931	931	0%	Enteric fermentation	814	
	Weaners	2451	2723	-10%		662	
	Growers and finishers	9129	19320	-52.8%		6011	
Slurry and manure storage		19691	20655	-4.7%	50	Slurry and manure management	88937
Slurry and manure application		7151	11919	-40%	738		

Your farm emissions

Reference system emissions

Reduction ratio

Figure 2. Farm environmental situation report



- Improvement proposals. This software provides the user several improvement proposal, related to:
 - o Abatement of emissions from facilities: nutritional, management and design techniques
 - o Slurry and manure management and storage improvement
 - o Water and energy consumption abatement
- Cost of pollutant abatement techniques. It is possible to get the estimated costs of pollutant abatement techniques, expressed as euro per place per year, and euro per kg per year.

CONCLUSIONS AND IMPLICATIONS

With the use of this tool, farmers and technicians are able to calculate ammonia, methane and nitrous oxide emissions, having taken into account the influence of the BAT selected over the whole productive process. This information is requested by EPER (soon PRTR) for those farms under IPPC regulation. Furthermore, thanks to this software, it is possible to estimate water and energy savings when best available techniques are implemented.

Finally, as an add-on tool, both farmers and technicians can achieve further information about the effect of best available techniques on emissions and consumption in order to improve the environmental situation of their farms.

Ongoing activities are aimed at the testing and validation of the developed software, through large groups of farmers so as to improve its efficiency both as an environmental-educational and as a decision-making supporting tool.