

Development of a software tool to calculate pollutant emissions, resource consumption and the effects of best available techniques on Spanish farms

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Abstract

This paper describes the development of a software tool supported and coordinated by the Spanish Ministry of Agriculture, Fisheries and Food (MAPA), 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.
- 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 resource consumption from Spanish pig and poultry farms. Seven work sheets 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 external manure management and 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.

- 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).

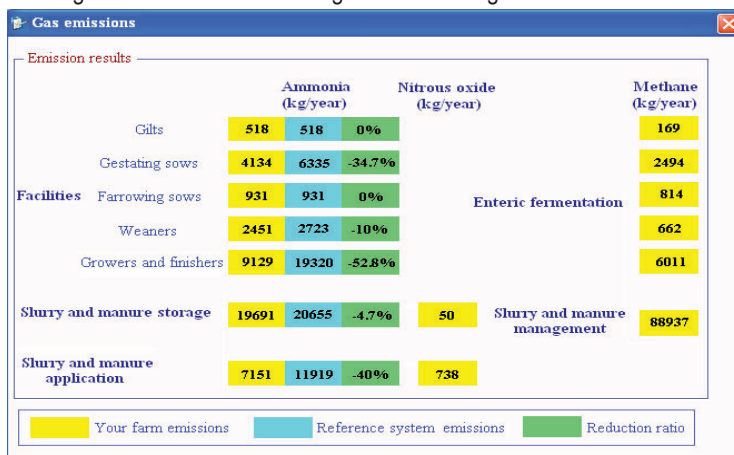
To calculate pollutant emission in each stage of the productive process, the software uses a mass-balance system, including the reduction ratios obtained from experimental trials carried out by MAPA in an environmental project conducted through 2003-2007.

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 sheet 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 numbers, animal type, facilities design, storage system and application system affect to these emissions.

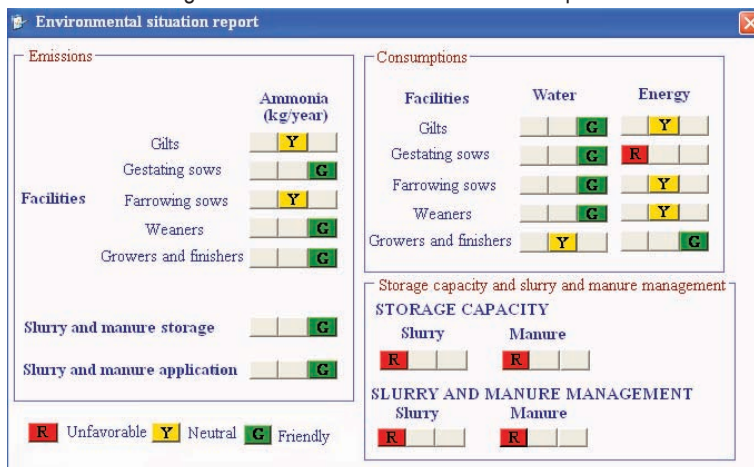
Figure 1. Screenshot showing the estimated gaseous emissions



- Water and energy consumption. The software application calculates water consumption from the farm, from the reference system, and a consumption reduction ratio. It is also possible to calculate the energy reduction ratio.

- European Pollutant Emission Register (EPER) information. Through this application the information requested by this European register can be got.
- Farm environmental situation report (Figure 2). This report summarizes the farm environmental situation with a code of colors:

Figure 2. Farm environmental situation report



- o Green (G): friendly environmental situation
- o Yellow (Y): neutral environmental situation
- o Red (R): unfavorable environmental situation
- 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.

Discussion

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.