INTEGRATED EVALUATION OF ORGANIC WASTE MANAGEMENT OPTIONS

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ABSTRACT

Livestock farms are among those agricultural activities considered more environmentally risky, and on which it is possible to act at different levels, improving the management in order to lower the environmental impact. Therefore, the principles of the Environmental Management Systems, provided for in some binding regulations (Directive CE 96/61) and some voluntary standards (ISO 14001, EMAS), have to be applied. For this purpose it is necessary that the livestock farmers perform an analysis of their actual management systems and an evaluation of possible critical points of the production activity. Structural aspects of the livestock farm and, above all, the housing and the manure management systems, represent a focal point of this analysis. However, the adoption of a single technique should be evaluated in the general context of the farm. In order to give a contribution in this direction, a first tool for an integrated evaluation of actual situations and possible improvement obtainable by applying BAT has been devised and implemented in a software programme. The preliminary simplified model developed is supported by a database containing the basic information related to the different techniques that can be utilised in a particular category of livestock farm, from feeding to manure utilisation. Each technique is characterised by an emission level toward air, soil and water and by an indicator describing the technical and economical feasibility of the technique.
Keywords: *IPPC, Best Available Techniques, manure management, intensive livestock.*

INTRODUCTION

Agricultural activities have been often assumed to have the main responsibility for emissions to air, and for surface and ground water pollution, from non-point sources. This consideration derives from the potential misuse of fertilisers, pesticides, slurry, manure, sludge, and compost, as well as from agricultural practices, which can cause uncontrolled releases of polluting substances contained in those products. The actual responsibility of farmers in the pollution sequence is related mainly to incorrect management of technical production techniques, and is not attributable to a deliberate, incorrect behaviour.

As known, a farm entails a complex activity where the manager must be able to combine and control different aspects of the production system with the main aim to maintain the economical sustainability of the enterprise. For this reason, in the last decades farmers have directed their effort on technical and managerial aspects related to increasing the production levels and reducing production costs, including those for manpower (Magette et al., 2001).

Just in the last years, the focus of the agricultural system has been oriented to include other aspects, related to issues such as environmental protection, animal welfare, food safety and to the multifunctional role of agriculture.

In fact, the increasing concern of public opinion and of legislators on the impairment of environment has pointed out the essential role of agriculture in the reduction of non-point source pollution.

The difficulties related to the implementation of a consistent system aimed at controlling emissions to the environment from agricultural systems must consider the objective technical

and managerial difficulties involved in putting in practice the best available techniques.

INTEGRATED POLLUTION PREVENTION AND CONTROL

From this viewpoint intensive livestock production merits special attention due to the different type of emissions it can generate. The European Commission estimated that the amount of nitrogen reaching directly or indirectly (trough deposition) the water of the member States is predominantly generated by agriculture (from 50 to 80%). Eighty percent of the emissions from agriculture are attributed to livestock activity (European Commission, 2000).

This is the reason why intensive pig and poultry rearing facilities of certain sizes are among the activities to which Directive 96/61/EC pertains. These facilities must obtain what may be called an integrated pollution prevention and control (IPPC) permit or licence from the Environmental Protection Agency.

Among other considerations, licence conditions shall be based on application of the best available techniques, without prescribing the use of any technique or specific technology, but rather taking into account the technical characteristics of the installation concerned, its geographical location and the local environment. If necessary, the permit shall include appropriate requirements to ensure protection of soil and ground water and measures concerning the management of waste generated by the installation (European Commission, 2003). BAT, therefore, consists of those technologies and practices that might be commonly called "best practice" for environmental protection (Bonazzi, 2002; Magette et al., 2001).

THE INTEGRATED EVALUATION MODEL

Implementation of BAT in an intensive animal rearing unit requires the evaluation of several aspects, which have to be considered in an integrated approach. The evaluation required is not an easy task as it must consider not only the reduction of the emissions to air, water and soil, but also the effect of the introduction of the chosen techniques on the whole plant, taking into account also the energy used, the water consumption, noise production, animal welfare, etc. The evaluation must be integrated in order to avoid situations such that the introduction of a specific technique, beneficial for controlling a single emission, could bring about a worsening of overall environmental performance of the whole plant.

Furthermore, it is of paramount importance to consider the economic constraints implied in the introduction of the new techniques. Finally, a special emphasis must be put on the management of the farm and the training of the staff.

The complexity of such an evaluation, which must give support to the farmer for decisions, requires the development of suitable tools that are able to identify the alternatives having the best cost/benefit ratio.

In order to give a contribution in this direction, a first tool for an integrated evaluation of actual situation and possible improvement obtainable by applying BAT has been devised and implemented in a software package. The preliminary simplified model developed is supported by a database containing the basic information related to the different techniques that can be utilised in a livestock farm, from feeding to manure utilisation. Each technique is characterised by an emission level toward air, soil and water and by an appraisal of the technical and economical feasibility.

In particular, the technical parameters taken into consideration for each technique refer to:
- emission to air (NH_3, CH_4, NO_2);

- emission to water (N, P);
- energy requirements;
- raw materials requirements;
- manpower requirements and related skill level;
- economic cost of the introduction of the technique (investment and running costs);
- effect of manure characteristics related to nutrient content, volume, variation of physical state (e.g. solid-liquid separation).

Moreover, each technique is associated with some qualitative factors in order to take into account some aspects that are not measurable, such as the difficulty of introducing a new practice in a farm, the effect of the technique on the relation of the farm with the neighbours (odours), or the effect of a practice on the recreational use of the landscape and on the improvement of environment (e.g. biodiversity).

The database of techniques contains also the phase of the production cycle where a technique can be used and, if applicable, to the category of animal for which the technique is appropriate. The database gives detailed information for each technique but it does not permit a user to identify the solutions that best fit the specific farm situation. To achieve an integrated evaluation it is necessary to consider also:

- the mutual compatibility of the different techniques. In fact, some solutions exclude automatically other techniques (i.e. if a full litter system is foreseen, it make no sense to evaluate the introduction of a solid-liquid separator); and
- the combined effect of different techniques adopted jointly.

With regard to the first point, a compatibility matrix has been defined, in order to identify the alternatives that can be adopted in from the viewpoint of technical and operational feasibility.

The second aspect has been addressed using the approach of multicriteria analysis, which permits a user to translate the farm and farmer requirements into constraints for the mathematical method.

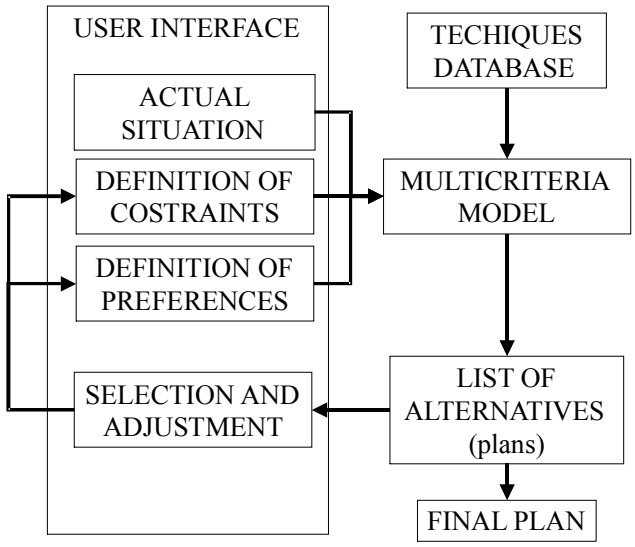

***Figure 1**. Scheme of the interaction of the user's interface and the model.*

The objectives that the method should achieve are:

- be sufficiently automated to produce alternative solutions in a reasonable time;
- be able to consider multiple structured objectives explicitly;
- account for multiple unstructured objectives by supporting interaction with solution processes;
- provide a mechanism for a direct consideration of farmers' preferences.

In particular, the latter point is managed by a user interface that can transform the intuitive inputs from the farmer into weights for the different para-

meters used in the model. Moreover, the software developed does not identify the best combination of techniques, but rather presents the alternatives ranked according to the costs and the benefits. The interactive and iterative process of selection can then produce the final plan suitable for the farm (figure 1).

CONCLUSIONS

The software, therefore, can be classified a Decision Support System to be used by technicians together with the farmers helping them to discuss and sort out the different solutions, taking into account the different advantages and disadvantages of alternatives and establishing the priorities for the farm according to the principles of the Environmental Management Systems.

Using such a model, a user can identify the possible Best Available Techniques (BAT) to reduce the emissions to air, soil, and water allowing a farm to adopt a management system that is environmentally safe and economically sustainable.

The actual development of the software requires a further activity of tuning and practical validation that will be performed in the near future. In this direction, it would be very interesting to gather knowledge and experiences from different groups in order to develop a methodology, supported by this kind of tools to help the farmer to manage their livestock in a more environmentally friendly way and to document and manage their practices in an EMS related to ISO14001 and EMAS certification schemes.

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