Extensive treatments for a piggery with minimal pollution

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Abstract

The impact of the breeding on the quality of waters in the Celtic countries is considerable. In Brittany particularly, porcine breeding is involved in streams, rivers or coastal waters pollution, the nitrogen being notably at the origin of problems of eutrophication and for supplying drinkable water.

It is necessary to add that the ammonia volatilized in buildings, even before ending in the atmosphere, falling again under dry and wet shape, or being at source of nitrogen oxides, can be a trouble for the well-being of the animals or the health of the men.

The Experimental Station of Guernévez (Finistère, France) thus decided to finalize a piggery combining four principles : a flushing under the slatted-floor, diluting enough the "fresh liquid manure" so that the volatilization of ammonia is considerably decreased; a sieving intended to retain a big part of the suspended material, as well as approximately 20 % of the nitrogen, the collected solid going out then to composting; a vermifiltration dividing by 5 approximately the nitrogenous load of the liquid effluent; finally a constructed wetland allowing to regenerate a water, approximately 90 % of which being of use to the system of flushing, the staying 10 %, corresponding sensibly in volume to the production of urine, being clean enough to be directly released to the environment.

All the points of the project presented here are today experimented in Guernévez. A whole integrating a 50 pig-equivalents pilot piggery and all the extensive treatments leading to water conservation and minimal pollution must be installed in June, 2006.

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Traitements extensifs pour une porcherie avec un minimum de nuisances

Résumé

L'impact de l'élevage sur la qualité des eaux dans les pays celtiques est considérable. En Bretagne particulièrement, l'élevage porcin est impliqué dans des pollutions de cours d'eau et zones côtières, l'azote étant notamment à l'origine de problèmes de potabilité et d'eutrophication.

Il faut ajouter que l'ammoniac volatilisé dans les bâtiments, avant même de se retrouver dans l'atmosphère, de retomber sous forme sèche et humide, ou d'être à l'origine d'oxydes d'azote, peut être une gêne pour le bien-être des animaux ou la santé des hommes.

La chambre d'agriculture du Finistère a donc décidé de mettre au point une porcherie combinant quatre principes : une chasse d'eau sous les caillebotis, diluant suffisamment les effluents frais pour que la volatilisation de l'ammoniac soit considérablement diminuée ; un tamisage destiné à retenir une grande partie de la matière en suspension, ainsi qu'environ 20% de l'azote, le solide récolté partant ensuite au compostage ; une lombrifiltration divisant par 5 environ la charge azotée du liquide effluent ; enfin un lagunage à macrophytes permettant de régénérer une eau servant à 90% environ au système de chasse, les 10% restant, correspondant sensiblement en volume à la production d'urine, étant suffisamment propre pour être rejeté directement dans l'environnement.

Tous les points du projet présentés ici sont aujourd'hui en expérimentation à Guernévez (Finistère, France), une porcherie pilote de 50 porcs-équivalent qui les intégrera devant être construite à partir de juin 2006.

Introduction

In most regions with intensive livestock production, excessive spreading of animal manure leads to water, soil, and air pollution. In Celtic countries, and particularly in Brittany, porcine breeding is involved in streams, rivers or coastal waters pollution. Therefore, the Experimental Station of Guernévez experiments both economical and extensive treatments for pig slurry in order to increase the farmers' motivation to treat. The objective of the present study is to analyse the feasibility of an integrated system piggery-treatment leading to water conservation and multiple outputs from various extensive slurry treatment steps (figure 1). Its principle lies in the association of :

- frequent flushing (1),
- slurry sieving (2),
- vermifiltration (3),
- macrophyte wetland (4).

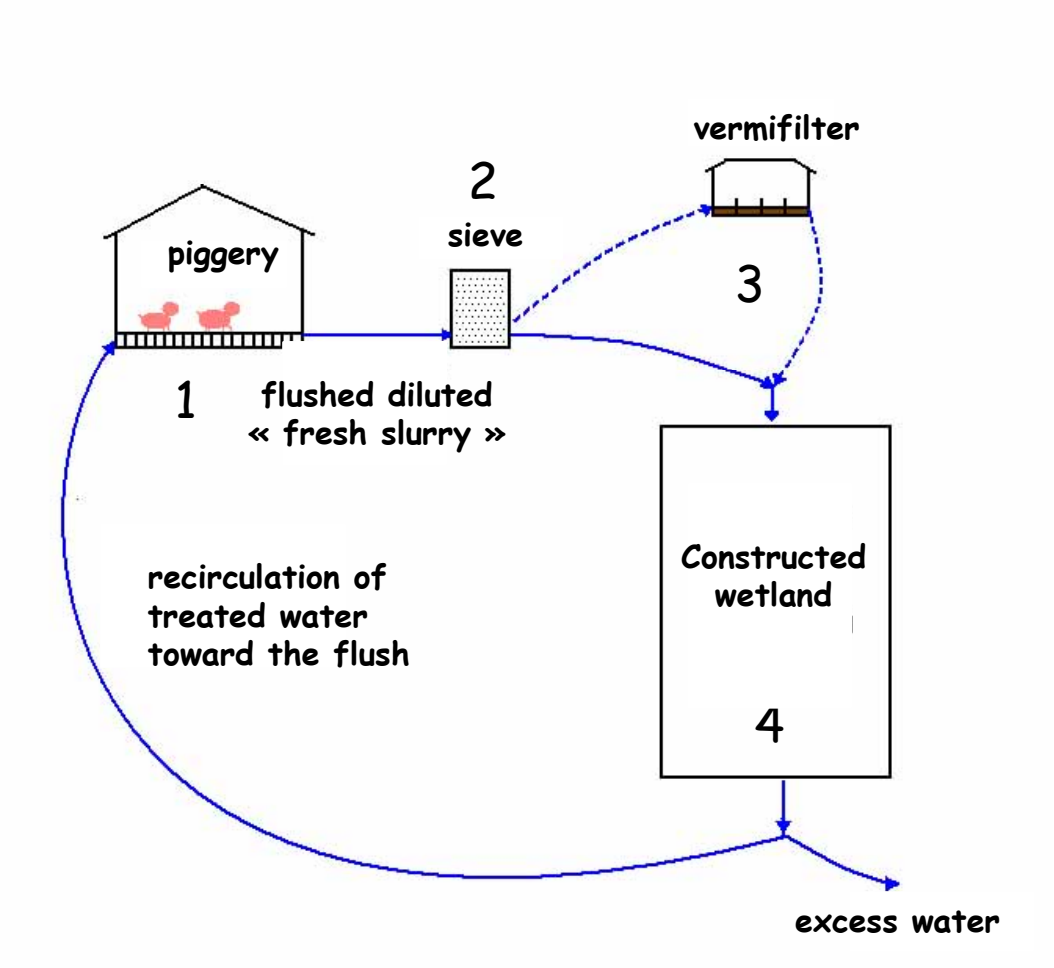

Figure 1. Outline of an integrated system piggery-treatment tested with the aim of minimal pollution.

1 - Standard slatted-floor piggery with flushing

A pilot piggery is equipped with a slatted-floor. The only difference with a classic piggery is the flushing system under the slatted-floor (figure 2a). Various systems were evaluated against there ability to remove completely the fresh liquid manure in order to reduce the sources of ammonia and odours. The system of one of the experimental piggery (figure 2b) has been taken up for the pilot piggery. The fresh liquid manure has to be flushed at least every 4 hour.

a b

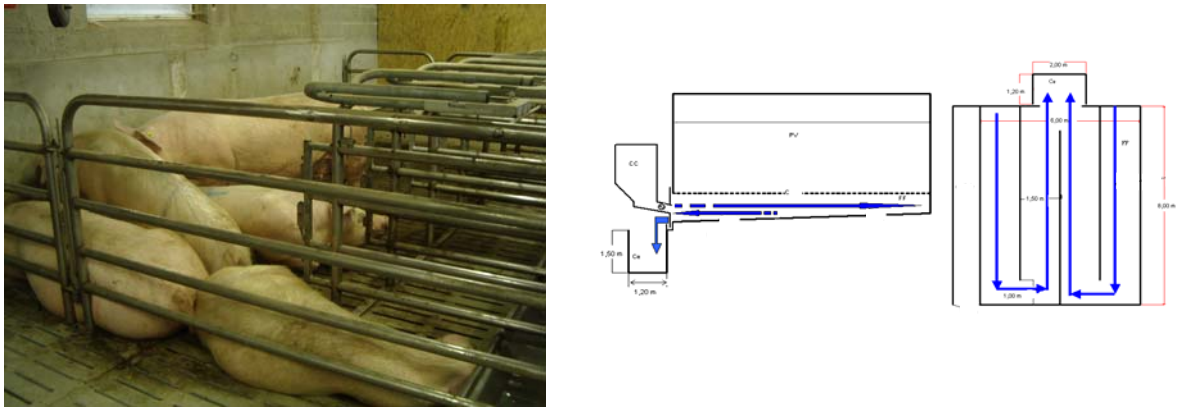

Figure 2. Piggery (a) with flushing system (b).

2 – Sieve

A sieve (figure 3) retains a big part of the suspended solids, as well as approximately 20 % of the nitrogen. The collected solid can be used as fertilizer or composted.

Figure 3. Sieve.

In the global conception, the sieve is an essential element, because it allows to decrease suspended solids and to reduce the sealing of the vermifilter (or, in its absence, one excessive sedimentation in the constructed wetland).

3 – Vermifilter

After sieving, the fresh liquid manure is sprayed on a substratum containing worms (vermifilter) (figure 4). The worms (*Eisenia andrei* and *Eisenia fetida*) withstand diluted slurry provided that the litter be porous enough. In vermifiltration both animals and vermicompost are produced.

Figure 4. Vermifilter.

The functional specificity of worms is double. By their movements, they generate galleries which are small lanes for the fluids (air and water) flows. Because of their proper activity and of the intense microbial activity in their faeces, they favour the decomposition of organic matters, even very slowly biodegradable, blocked in the filter, and, globally, a loss of nitrogen, attributed to a denitrification, which divides by 5 approximately the nitrogenous load of the liquid effluent.

There is no accumulation of muds, pulled by the vermifiltered water.

4 - Macrophyte wetland

The installation of a constructed wetland downstream from the vermifilter was chosen to end the purification of the effluent rather than that

of a microphytes lagooning, because it requires a smaller surface (approximately 100 m2 per pig for the microphytes, against 20 for the macrophytes without previous treatment system of liquid manure, 4 with vermifiltration) and presents a higher stability of the plant material. Successive lagoons allow both further purification of the liquid and various plant production chosen for biomass productivity, fibber by-products, animal food properties, ornamental quality, pharmaceutical content. The system being installed consists of 3 series of 4 ponds in parallel (2 in floating plants, the first one serving as settling pond, and 2 in horizontal (figure 5) or vertical fixed beds). Major part of the purified water will be used for flushing, the rest being released.

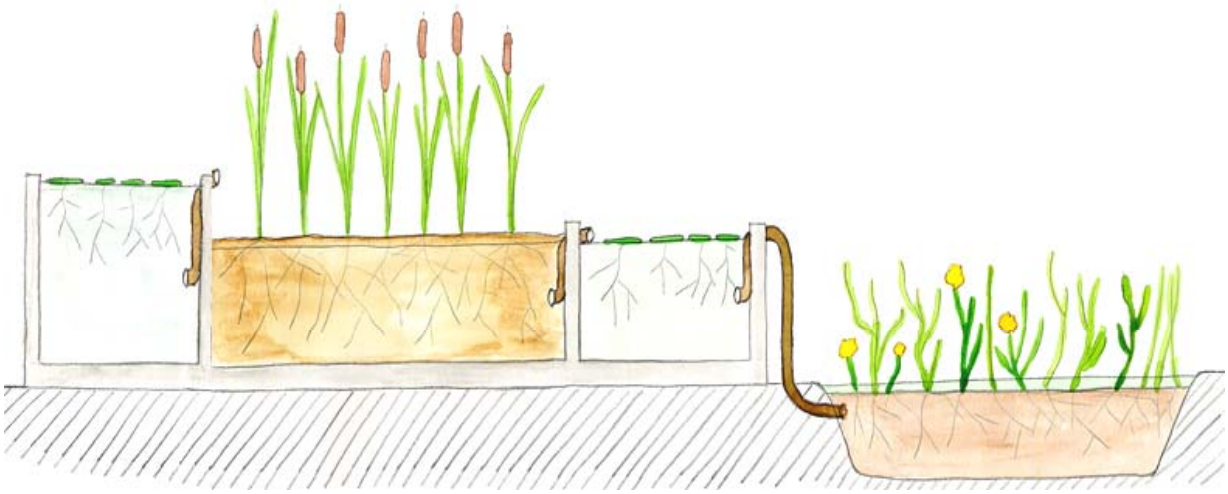

Figure 5. Scheme of constructed wetland.

The tested plants are, at first : *Elodea canadensis*, *Hydrocotyle vulgaris*, *Utricularia vulgaris*, *Azolla caroliniana*, *Eicchornia crassipes*, *Pistia stratiotes*, *Acorus calamus*, *Carex riparia*, *Iris pseudoacorus*, *Juncus inflexus*, *Mentha aquatica*, *Phragmites australis*, *Schoenoplectus lacustris*, *Typha latifolia*, *Lemna gibba* et *Lemna minor*, *Glyceria aquatica*.

The experiment of the artificial wetland will last one year (until June, 2006) with by-pass of the vermifiltration and thus dilution of the fresh liquid manure. The dimensions of pond presented in figure 6 allowing to treat the liquid manure equivalent to 1.6 pig.

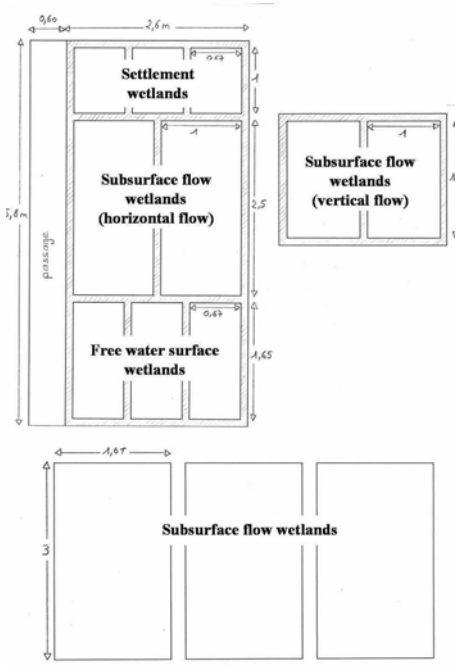

Figure 6. Plan of constructed wetland for the treatment of the 1.6 pig fresh and sieved manure.

First results

Ammonia did not accumulate in the system because of rapid adsorption on organic matter after flushing, and progressive organisation by the biomass. Furthermore, the experiment confirmed a very significant decrease (60 to 80%) of the ammonia concentration in air in and near the buildings thanks to flushing.

Optimal size appeared to be around 0.3 m^2/pig for vermifiltration to treat all the sieved fresh slurry.

A decrease of the ammoniacal nitrogen and, at the same time, an increase of nitrates after the passage of the "fresh liquid manure" in the vermifilter was noticed. The decrease in total nitrogen ranged from 60 to 82 %. Analyses gave, by instance, 7000, 1530, 860, 175 mg/L total N, and 2500, 1005, 540, 100 mg/L N-NH_4^+ respectively for standard liquid manure, diluted fresh liquid manure before and after sieving, and vermifiltrate.

Further work is needed to evaluate the gas emitted during the process and the element repartition between the various stocks.

RedOx potential of the liquid is a critical value for the control of vermifiltration. It should remain positive in order to preserve the worm populations.

Conclusion

The first results obtained with vermifiltration and wetlands this year will lead to the design of a larger pilot connected to a new piggery in June 2006. Various species will be evaluated in the framework of a FEOGA program. In parallel of the installation of an artificial wetland on a surface from 100 to 200 m2 on a nearby field (figure 7), the experiment will continue on the today fitted site, to know the long-term evolution of the plants and allow possible corrections on this installation.

Figure 7. Field area reserved for the treatment of 50 pigs effluents.

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