The use of Integrated Constructed Wetlands for the treatment of swine wastewaters

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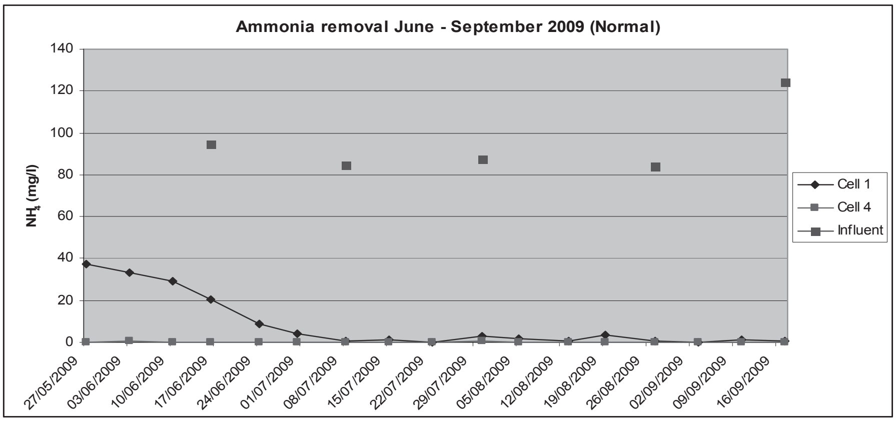
Introduction The treatment of agricultural wastewaters (yard runoff, dairy washings, slurries) by means of land-spreading is under scrutiny due to the EU Nitrates Directive, which limits the amount of nitrogen that can be applied to land. These limits have particular challenges for Piggery management, because they have limited access to spread-lands compared to other farming enterprises. This makes the nutrient content of pig slurries a potentially costly issue to address. The use of alternative methods to supplement or even replace land-spreading have been investigated for several decades with Constructed Wetlands showing potential for the treatment of agricultural wastewaters, including that of swine wastewater (slurry). The objective here was to examine the treatment efficiency of an Integrated Constructed Wetland (ICW) approach for the treatment of anaerobically digested swine wastewater. ICW systems are surface-flow constructed wetlands that treat wastewaters through means of natural processes, sedimentation, mineralization, plant and microbial uptake, denitrification, nitrification and atmospheric releases.

Material and methods A series of Meso-scale wetlands was developed in Teagasc Centre, Moorepark, Fermoy, Co. Cork to examine their treatment efficiency of swine wastewater from an anaerobic digester. After an extensive examination of the literature the use of the ICW concept (Harrington and Ryder, 2002) was decided upon and 4 key treatment operations were identified; high and low hydraulic loading, nutrient loading and effluent recycling. Polyethylene containers were used to construct 16 systems to examine the 4 treatments, with each treatment having 4 replicates. Each system comprises of 4 cells with a total system area of 0.788m^2. The influent to the cells is separated swine wastewater post-anaerobic digestion. This liquid is diluted down to set ammonia (NH_4) concentrations. These systems were identified as normal, recycling, high nutrient loading and high flow rate. The parameters of these systems is outlined below;

1) Normal: 37m^3/ha/day loading rate @ 100mg/l NH_4
2) Recycling: 37m^3/ha/day loading rate @ 100mg/l NH4 with 100% effluent recycled through the system weekly.
3) High Nutrient Loading: 37m^3/ha/day loading rate @ 200mg/l NH_4.
4) High Flow Rate: 74m^3/ha/day loading rate @ 100mg/l NH_4.

These systems run continually under automated pumping mechanisms adhering to the application rates above. Sampling of the Meso-scale systems is performed weekly. Storage tanks containing the influent, cells 1 and 4 of each system are sampled. Each sample is analysed for ammonia, molybdate reactive phosphorus, nitrate, nitrite, total oxidised nitrogen and chloride. BOD5 is analysed fortnightly.

Results The initial removal rates in January of 2009 showed an average ammonia removal rate of 99.5%. During March-May the removal rates dropped to 75% during freezing temperatures. The removal rates of ammonia have averaged over 99% during the period of June-September 2009.



Conclusion The treatment of swine wastewaters by Constructed Wetlands has been demonstrated over several decades. The use of ICW as demonstrated in this Meso-scale study has shown that ICW could be a very effective approach to swine wastewater management. The Meso-scale study has shown removal rates of up to 99.5% for ammonia and phosphorus. They require a large land area for adequate construction and implementation in comparison to the land requirements of storage lagoons, filtration systems or anaerobic digesters. However, based on loading and sizing, it is significantly less than that which is required for sufficient land-spreading. They have also been shown to have greater treatment efficiency than those methods listed. There are also numerous additional benefits to the use of such systems, including the removal of non-point pollution sources, economic benefits, carbon sequestration, the potential for residual energies from dried accumulated organic matter than could be used as a fertilizer, biodiversity and habitat creation.

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