Technical Note

Estimation of Pollution Caused by Swine Production in Camagüey, Cuba

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INTRODUCTION

Food production in Cuba is a strategic priority of the state (PCC, 2016); in 2010, swine production alone accounted for 225 000 tons (Sosa *et al*., 2017). Production takes place on 135 farms (4 681 farmers) with production agreements with the state for fattening (Provincial Commercial Swine Breeding Company, 2017); however, this activity causes a great deal of environmental pollution (Barreto and González, 2008).

Many production farms have inefficient systems for residual water treatment (Sosa *et al*., 2017), thus causing a negative impact on the environment (Barreto and González, 2008; Méndez *et al*., 2009; Wakia *et al*., 2018). As a result of their contribution with organic matter, nitrogen, and phosphorus, new means and methods are required for treatment and less aggressive disposal into the environment (Ye, Song, Wang and Zhu, 2016); (Wakia *et al.*, 2018).

An estimate of the contaminants pumped into the environment by these facilities may be known thanks to evaluation of the characteristics of the animal population, management, treatment, and disposal of liquid wastes (Barreto and González, 2008). (Méndez *et al*. 2009). Several indicators were used in this research to determine the volume and characteristics of the residual water disposed of by five farms in the province of Camagüey.

DEVELOPMENT

Qualitative evaluation of residual treatment systems was performed on five production farms in the municipality of Camagüey, by means of inspections and interviews, in terms of cleaning procedure, nutrition, and frequency. Then pollution was estimated based on the indicators referred to by Barreto and González (2008), in $kg \cdot d^{-1} \cdot AE^{-1}$; 0.66 COD[1], 0.33 BOD[2], 0.6 TSS[3], 0.05 N_t[4], and 0.013 P_t[5]. Flow was determined by assuming consumption of AE[6] of 50 L at the beginning and 100 at the end.

To evaluate the systems installed for residual water treatment and determination of the quality of water dumped into the environment or run through the watershed, the removal efficiency from septic tanks was assumed at 30% (Ministry of Economic Development, 2000; Madera, Silva and Peña, 2011); and 60% from ponds (Ministry of Economic Development, 2000; Díaz, 2010).

Statistical processing was done by descriptive statistics (average values and standard deviation), using STATGRAPHICS XVI.II.

Overall, farmers have residual evacuation systems. On all the farms, except for the Viera Agreement, after cleaning, the residuals without solid separation run through open ditches from the houses into the solid

[1] Chemical oxygen demand.
[2] Biochemical oxygen demand.
[3] Total suspended solids.
[4] Total nitrogen.
[5] Total phosphorus.
[6] Animals equivalent to 100 kg live weight.

ISSN 2224-7920

separation tanks, and then to water ponds dug in the ground or in natural depressions without waterproofing. Instead of a septic tank, the Vieras have an anaerobic digester with a fixed top, “Asian type”. No pond overflows, so the residues may filter into to the water table, except for La Yaba farm tank (flowing through a banana plantation), and the Viera (flowing to open ground and into a basin where residues accumulate, and upstream past a dirt road by the homes.

The water consumption estimates per farmer at the beginning and end of the cycle are expressed in $m^3 \cdot d^{-1}$[7], as follows: La Majagua (0.35-8.5), “El Gran Mil” (1.05-28.5), Los Manguitos (0.21-6), Los Viera (5.31-79.05), and La Yaba Farm (0.31-5.05). In all the cases studied, the number of animals per farmer varied between 50 and 850 on each farm. The average weight in $kg \cdot AE^{-1}$ was 4-106 at the beginning ($\bar{x}$= 29) and 50-791 at the end ($\bar{x}$=254); therefore, the flow generated was determined by AE at the end of the cycle (5 $m^3 \cdot d^{-1}$ at 79.05 $m^3 \cdot d^{-1}$($\bar{x}$=25 $m^3 \cdot d^{-1}$)).

The characteristics estimated were given in $mg \cdot L^{-1}$: COD 739.2 in Majagua and Gran Mil; 2 772 in Manguito; 4 620 in Viera; and 1 846 in La Yaba. The respective BOD per farmer was 370 for the first two; and 1 386, 2 310, and 923 for the rest. The TSS content was 480 for the first two, and 1 500, 3 000 and 1 199 for the rest. The N_t content was 500 for all, except for La Yaba, with 499. Pt was 131 for Majagua and La Yaba; and 130 for the rest. The above proves that the residues disposed of were beyond the top limits (NC, 2012), due to multiple reasons. On one hand, the treatment systems do not have the phases needed to meet such requisites. On the other, the existing facilities do not usually meet the requirements for proper operation (Ministry of Economic Development, 2000). Several construction issues have been detected in the ponds, such as poor waterproofing conditions, which cause pollution of the water table by infiltration (Méndez *et al.* 2009).

The treatment systems in Majagua and Gran Mill were the most efficient ones, and were complete. They enjoy primary treatment and two serial anaerobial ponds. Manguitos and La Yaba have only one anaerobial pond each. Manguitos is in clear disadvantage in terms of efficiency, since the retention time is less than 5 days, though there are reports that 45-70% BOD_5 can be reduced in 2 days (Alamancos Sáez and Llorens, 1993). Although the Vieras are the only ones that produce and use biogas from residues, they also generate the highest pollution, because treatment is only performed through a digester whose COD and BOD removal should be 50-70% (Barreto, 2008). The effluent causes an unpleasant smell around the neighboring homes, and it creates a favorable substrate for fly development. Additionally, it pollutes the nearby wells, and contributes to the emission of greenhouse gases.

CONCLUSIONS

The facilities built to treat residuals are insufficient and their exploitation is inadequate.

The disposal of liquid wastes from swine farms have contaminating concentrations exceeding the agreed volumes (NC: 27, 2012), and may potentially pollute soils, and surface and ground waters.

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[7]The first of the values between parentheses

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Received: 9-10-2018
Accepted: 9-16-2018