SLURRY MANAGEMENT IN DAIRY GRAZING FARMS IN SOUTH AMERICAN COUNTRIES

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1 INTRODUCTION

Milk production is important in South American countries, where Argentina, Chile and Uruguay account for 15% of the South American dairy herd producing 25% of the milk of this region (FAO STATS, 2010), based on pasture systems. Dairy slurry management has become an important issue in these farms because of the large volumes produced and the environmental effects.

To assess the impact of farm management practices is important to have reliable information, especially with respect to manure production and use. This is key information for gaseous emission inventories and regulatory normative and policies. In the South America countries surveyed in the present study, there is not official information about manure management and this information is not considered in national census, which is similar to other countries elsewhere (Menzi et al., 2004). They mentioned that generally it is use expert opinion and experience to know about these farm practices.

The aims of this work were to analyse the management of slurry on dairy fams in countries of South America (Argentina, Chile and Uruguay) and to identify potential options to reduce the risk of pollution and issues where research and technology transfer is required.

2 METHODOLOGY

The analysis of dairy slurry was based on surveys and measurements on farms, published literature together with expert judgement of researchers working in this area.

Information in Chile was collected from 155 dairy farm located in the southern regions (39 to 44 S and 71 to 74 W), which concentrated 85% of the Chile milk production. A complete description of the methodology is presented in Salazar et al. (2003, 2007). Briefly, a questionnaire was used to obtain information when visiting each farm about housing period, animal-stocking rate, clean and dirty water production, manure application and storage capacity. During farm visit measurement were carried out to quantify slurry production and use of clean water. Also, slurry sample from each farm was collected for laboratory analysis.

In Argentina information represent mean values between data coming from the Central Basin (30% of overall production) and from the Buenos Aires Basins (30% of overall production). Data was provided by Charlón et al. (2000), Charlón (2007) and Taverna et al. (2004) for the Central Basin and, by Nosetti et al. 2002 for the Buenos Aires. Slurry characteristics were obtained through sampling and analysis in 63 dairy farms. Information of water use was obtained by on-farm water quantification of different operations during milking, in different dairy basins (n= 63), and an average was calculated to obtain a unified value. Information of slurry use, management and treatment was collected using surveys which were focus on farmers and milking machinery providers and represent 329 farms. With the available data, a database was built to evaluate these aspects in dairy farms in Argentina.

The information in Uruguay was collected through survey and direct measurements. For water use measurements were made in 20 farms from the Montevideo basin. Slurry characteristics were obtained from sampling 20 dairy farms. Information of slurry use and management was collected from a survey from 621 dairies.

3 RESULTS AND DISCUSSION

Slurry is the most important organic residue on dairy grazing farms with large volumes produced characterised for a high contribution of rain and cleaning water. Raw slurry is generally applied to agricultural soil, with only few farms using a physical treatment for separation, and some farms in Uruguay using biodigestion (Table 1). Dairy slurry is applied mainly to grassland and crops (e.g. corn and sorghum) all year around, with no legislation to control rate or time of application in these countries. Generally, farmers did not take into account the nutrient contents of slurry; which is similar to that found in other countries elsewhere (Smith et al. 2001). Most dairy slurry is applied by surface broadcasting systems, either high-pressure irrigation system (e.g. irrigation gun), tank spreader or a combination of both. These methods have the disadvantage of causing air pollution due to gases or odours. A high proportion of dairy farmers store slurry in earth-banked lagoons or lagoons lined with concrete, and recently is becoming popular the use of high density polystyrene or PVC for lining.

Slurry analyses showed similitude among the countries surveyed with low dry matter contents (Table 2), which is similar to dairy farm based on grassland systems (Longhurst et al., 2000). However, nutrient content in slurry is low compared to those reported in other countries (e.g. Westerman et al. 1985) and variable, which could be associated with differences in animal feeds, animal type, animal age and manure management. This could be explained by short or no confinement periods on these dairy grazing systems and a high contribution of water from cleaning, mainly on yards (Table 1). Also rainfall entering direct or indirect to the slurry stores from unroofed areas is important. In these countries dairy production is based on regions with high rainfall regime ranging from 800 to 3.000 mm yr^{-1}. Water for milking operations in all three countries comes mainly from groundwater private wells and their use is similar to dairy farms located in United States (Willers et al., 1999). Alternatives such as diversion of rain water and recycling wastewater for washing floors can be consider reducing water pumping.

Regular surveys on farm and manure management practices are a valuable tool for informing research, extension and policy. Also, the private sector (e.g. manure machinery and traders of manure handling equipment) could use this information to focalize the products to be offer to the different countries and regions depending on particular manure management system previously characterized in each of them.

TABLE 1 **Use, management and treatment of dairy effluent and use of water for cleaning on dairy farms in South America.**

	Argentina	**Chile**	**Uruguay**
Dairy system	Mainly all day grazing >> housing	Mainly all day grazing > housing	Mainly all day grazing Some temporary dry lot in winter
Use in	Mainly forage crops (maize, sorghum, ryegrass) >> pasture	Pasture > crops, mainly forage maize	Pasture and crops corn and sorghum
Rate of application	30 – 90 m^3 ha^{-1} yr^{-1}	10 – 300 m^3 ha^{-1} yr^{-1}	No data
Time of application	All year around	All year around	All year round
Main equipments used	Slurry tank >> irrigation pump	Irrigation pump > slurry tank > travelling irrigators	Slurry tank, irrigation pumps
Use of effluent	Mainly raw effluent	Mainly raw effluent	Mainly raw effluent
Effluent treatments (if it is used)	Physical separation	Mechanical or physical separation	Physical separation
Storage	Earth bank lagoons	Earth bank lagoons > concrete tank > and HDPE and PVC lined lagoons	Earth bank lagoons (one lagoon, or more than one)
Biogas	No	No, only experimental plant	Very few farmers

Water use for cooling system for milk	Theorically 2.5-3 litre per each litre of milk. Measured in farms 6.3 (4 – 10)*	Theorically 3 litres per each litre of milk	NA
Water for cow's udders[1]* (L)	1.4 (0 – 3.5)	No information	NA
Water for Yard cleaning[1]** (L)	21.6 (7 – 80)	31.2 (2.0 – 169.4)	32,9 (6-88)
Water for milk equipment cleaning[1]*** (L)	3.03 (1.32 – 4.45)	4.5 (1.5 – 11.1)	NA
Water for milk tank cleaning[1]**** (L)	1.32 (0.91 – 1.74)	1.1 (0.5 – 2.3)	NA

NA: not available information

[1] $litre.cow^{-1}.day^{-1}$ for a 100 cow dairy farm (2000 kg milk)

Argentina *n= 40; **n= 56; ***n= 60; ****n= 60; Chile **n= 39; ***n=54 ****n= 50; Uruguay** n=20

TABLE 2 **Dry matter and nutrient contents on dairy effluents of South America, fresh weight basis (average ± standard error).**

Parameter	Unit	Argentina	Chile*	Uruguay
Dry matter	(%)	1.21± 0.84	2.7 ± 0.23	1,05±0.77
Kjeldahl total nitrogen	(kg N/1000 L)	0.42± 0.36	1.28 ± 0.087	0,27±0.09
Ammonnium nitrogen	(Kg $N-NH_3$/1000 L)	0.33± 0.16	0.50 ± 0.031	0.19±0.07
Phosphorus	(kg P_2O_5/1000 L)	0.20± 0.12	0.47 ± 0.038	0.13±0.07
Potassium	(kg K_2O/1000 L)	0.33± 0.13	1.06 ± 0.071	0.49±0.09
Magnesium	(kg MgO/1000 L)	NA	0.30 ± 0.022	NA
Calcium	(kg CaO/1000 L)	NA	0.61 ± 0.050	NA
Sodium	(kg Na/1000 L)	NA	0.19 ± 0.012	NA
Sulphur	(kg S/1000 L)	NA	0.11 ± 0.009	NA
Zinc	(g Zn/1000 L)	NA	19.2 ± 3.07	NA
Iron	(kg Fe/1000 L)	NA	940 ± 175.9	NA
Manganese	(kg Mn/1000 L)	NA	52.7 ± 7.00	NA
Copper	(kg Cu/1000 L)	NA	25.3 ± 8.47	NA

NA: not available information

* Argentina= DM (n= 63); N, NH_3, P, K (n= 48)

** Chile= DM, N, $N-NH_3$, P, K, Mg, Ca, Na (n= 151); S (n= 100); Zn, Fe, Mn y Cu (n= 147)

*** Uruguay= DM (n= 28); N, NH_3, P, K (n= 25)

4 CONCLUSIONS

Slurry is the most important organic residue on dairy grazing farms with large volumes produced characterised for a high contribution of rain and cleaning water and low dry matter and nutrient contents. The information collected has helped to identify problems in slurry management in South American dairy farms and areas where research and technology transfer will be necessary to avoid pollution and to improve the use of manure nutrients. There are many aspects that should be improved on dairy farms, such as reducing slurry production, increase and improve storage, rate and time of application and the use of more efficient equipment in order to reduce pollution and to increase the recycling of nutrients in these production systems. An important action will be to coordinate periodically slurry management surveys and data analysis using the same approach across South American countries. We suggest a coordinate research network on manure management for South America countries as RAMIRAN, and elaborate protocols of sampling and analysis for these countries.

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