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Determination of indirect water consumption and suggestions for cleaner production initiatives for the milk-producing sector in a Brazilian middle-sized dairy farming

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ABSTRACT

Current research measured the indirect water consumption in the milking process in a medium-sized dairy farming in the southwestern region of the state of Bahia, Brazil, to foreground the environmental management of water resources. The environmental impact associated with indirect water consumption throughout milk production (from milking to the moment milk is dispatched) was identified. The water consumption coefficient in the milking sector averaged 3.4 L-1 of milk produced, for 541 L of water consumed and a daily milk production close to 160 L. It should be underscored that professionals who deal with milking and cleaning activities have little or no instruction about the adequate use of water. Cleaner Production (CP) initiatives have been identified. It was proposed to the milking personnel that, if the initiatives are applied properly, they may contribute towards the reduction of water consumption and wastes without affecting either the quality of the final production. These initiatives comprised small and big actions such as staff training and replacement of cleaning equipment and fertilizing irrigation, which may immediately contribute towards the prevention or reduction of wastewater during milking. The qualitative and quantitative interpretation of data would contribute towards CP initiatives that might be implemented at the milking sector in the short, medium and long terms.

1. Introduction

The Brazilian agribusiness sector is responsible for 28% of the Gross Domestic Product (GDP), 36% of exports and 37% of jobs and global leadership in commodity products (Brazil, 2013). It may be affirmed that agribusiness is highly relevant in the Brazilian economic, social and environmental context. However, it should be unlderscored that the sector, represented by various producers country-wide, takes place at various organizational levels and technological properties, from family farms and small cooperatives to mechanized installations and processing, transformation industries. This technological diversity directly influences job creation, income and environmental impacts.

Inserted in this context, Itapetinga in the southwestern part of the state of Bahia, Brazil, is an important microregion that emerged as an agro-pastoral area due to the good quality of its soil and climate, especially for livestock (Ferreira et al., 2005). According to official sources, the livestock sector contributes with approximately 2% of Itapetinga's GDP, producing 3,200,000 L of milk from one of the biggest cattle herds in Bahia (IBGE, 2012).

In compliance with the Agriculture Defense Agency of Bahia (*Agência de Defesa Agropecuária da Bahia*), the Itapetinga region has currently approximately 6600 rural properties with at least twenty thousand people, most of whom dedicated to livestock. Nevertheless, there is a need for more technical support from governments and institutions related to research and technical assistance to overcome problems, such as the scarcity of rainfall, which have demanded a better use of available natural resources. These issues are confirmed by the Itapetinga Rural Membership which underscored the use of new techniques to increase productivity and to overcome difficulties, including the lack of water (Peixoto, 2010).

In fact, water availability levels in Itapetinga microregion may compromise livestock development, especially dairy farming, since water is one of the most important factor for production in this sector (Ferreira et al., 2000). Water mismanagement makes its availability scarcer and affects its quality through effluent

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discharges which are considered the most significant environmental aspects of the dairy sector. Therefore, the rational use of water is important for the sector, aiming at its maintenance, development and expansion. However, the need for conservation practices usually becomes more evident only when many supply sources start deteriorating. The above is compounded by low rates in wastewater treatment, fragility in implementing policies for water source protection and non-adherence to good farming dairy cattle practices (Florencio et al., 2006).

The dairy cattle's water consumption comprises the daily water needs for each animal and other uses, such as cleaning milking installations and equipments that should also be considered. It is important to emphasize that water is the most relevant factor for dairy cattle. Since milk contains 87% of water, lactating cows need more water per body weight than other animal categories (Embrapa, 2006). Water quality is a good indicator of environmental impact in cattle farming so that any failure in management will result in the degradation of water quality and in that of the surrounding environments.

Risks to water quality are increased when there is inadequate storage of animal wastes or are used as fertilizers without pretreatment. Studies also points out that the greatest agricultural water pollution is derived from the farmyard area and its vicinity. In recent years, the discussion about environmental sustainability has broadened to include the impact of agricultural production (Ruviaro et al., 2012). The increasing worldwide demand for food, feed and renewable energy sources requires new knowledge and challenges about production systems to make them acceptable under sustainability criteria. Changes in agricultural practices become necessary with the implementation of methodologies, such as a cleaner production, to prevent negative impacts on the environment, particularly soil and water pollution (Galka, 2004).

Taking into consideration water management in dairy farms, first there is a need to identify entire consumption and the critical points in the production process, i.e., those with significant impacts. This attitude contributes towards the development and implementation of good production practices in such places to achieve the best efficiency in the process and decrease environmental impacts. According to Thomas (2007), water usage on dairy farms may be divided into two general categories: direct usage by dairy animals and indirect usage required for the general operation of the dairy facility. After the identification of the critical points, cleaner production initiatives and changes in the production process may be proposed to effectively reduce environmental risks.

Further, there has been a growing interest in studying water consumption since this input is becoming increasingly scarce. Several methods have been developed to evaluate water use in production processes by analyzing the amount consumed and its environmental impacts. With regard to water consumption, recent research has shown that about 27% of human water consumption is related to animal production (Mekonnen and Hoekstra, 2011). De Boer et al. (2013) assessed the environmental impacts associated with fresh water consumption through the Dutch milk production cycle in Noord-Brabant. In their study, these authors also mentioned that several recent papers investigated the assessment of site-specific environmental impacts associated with freshwater use in the cycle of an animal product (Milà i Canals et al., 2009; Pfister et al., 2009; Bayart et al., 2010; Berger and Finkbeiner, 2010; Ridoutt and Pfister, 2010).

Current research measures the indirect water consumption during the milking process in a medium-sized dairy farming so that the environmental management of hydric resources could be evaluated. In the wake of results, it is possible to indicate cleaner production initiatives or practices that are more suitable to the sector under analysis while taking into account that water use reduction is the solution of wastewater problems.

2. Methodology

Research was performed in the milking sector of a middle-sized dairy farming in the southwestern region of the state of Bahia, Brazil. Cattle herd consisted of 19 female Girolanda calves. Indirect water use for milk production in the milking sector was evaluated and activities were indicated to mitigate potential environmental issues in the production system adopted on the farm (Fig. 1). Coefficient of individual water consumption, the ratio between water consumed and milk produced, was calculated.

Since the study focuses on the milking production stages including cleaning, the system boundaries did not include the previous (e.g. crop production) and after (e.g. transportation) stages. Data on water consumption were collected during 13 days by in loco observation of the process. Interviews with employees were held to obtain information on daily milk production and its process. The water volume consumed in the production process was established during data collection by first determining the water flow during the milking stages of milking comprising water consumption. The flow was determined by measuring the time to fill a container with a known volume. The time to perform the activity at each stage was determined by a chronometer. Based on the results, studies were performed for cleaner production initiatives suitable for the process and aiming at water consumption reduction during milking, without impairing the quality of production and the cleaning process, which is an utmost importance factor in milk production. The CP methodology (Fig. 2) follows levels proposed by CNTL - Clean Technologies National Center (*Centro Nacional de Tecnologias Limpas*), the Brazilian Center of UNIDO - United Nations Industrial Development Organization/ UNEP - United Nations Environmental Program, Cleaner Production Network (CNTL, 2003).

CP priority must be achieved at Level 1: Reduction or elimination of produced wastes, emissions and/or waste. If waste is generated, it must be initially reintegrated to the productive process (Level 2) by performing internal recycling to recover inputs, raw materials and industrial materials. When internal recycling is not possible, external recycling strategies may be used (Level 3). Such CP techniques may be adopted in any activity although changes in attitudes are required from all workers directly or indirectly involved in the production process (CNTL, 2003; Seiffert, 2011).

3. Results and discussion

3.1. The milking sector: production and cleaning process

Three stages of the milking process with water consumption during production were identified and classified: (i) cleaning of udder, (ii) cleaning of tools and equipment and (iii) cleaning of the milking parlor (floors and walls). Two different hoses are used in the process: one considered as “low flow” (h1), with a device for flow control; the other, named “high flow” (h2), do not have any flow control.

Average daily production is approximately 160 L of milk which are obtained from the cows by milking machines. Before milking, each animal is tested for mastitis. If a negative result is obtained, the cow's udder is disinfected and washed with hose h1, even though sometimes hose h2 is used for cleaning the udder. A solution containing water (10 L) and a sanitizing product is previously prepared to clean-up the liners after each milking since they have direct contact with the animal's udder.