TENDÊNCIAS DA CONTABILIDADE DE FLUXO DE MATERIAIS NA PRODUÇÃO ANIMAL BRASILEIRA: CONSIDERAÇÕES E PERSPECTIVAS PARA DESENVOLVIMENTO DE PESQUISAS

TRENDS OF MATERIAL FLOW ACCOUNTS IN THE BRAZILIAN LIVESTOCK SECTOR: INSIGHTS AND PROSPECTS FOR RESEARCH DEVELOPMENT

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INTRODUCTION

Given the importance that Brazil has as one of the largest food producers and exporters in the world, the country has been regarded as the "barn of the world". For increasing its productions, the country relies on its huge agricultural space and it goes through an intensification process (increase of inputs/ha, animal densities etc.), specialization and territorial segregation between agricultural land and livestock. However, it is not always considered that the Brazilian agricultural production is significantly dependent on high volumes of some inputs like fertilizers (N, P), that the country has low level of autonomy. Moreover, dealing specifically with the production of animal protein, some activities generates significant amounts of manure that are freely disposable in the environment and at the same time, there is an overuse of chemical fertilizers. All this greatly modifies the nutrient cycles, and generates negative externalities. The efficient use of nutrients and its corollaries (losses in the environment) are not well documented yet, this challenge have become part of national and international agenda.

Farming practices that are less environmentally impactful have been developed and spread in Brazil. Examples are the no-tillage system, crop-livestock integration, crop rotation, intercropping, organic production, among others. Regarding the problem of animal waste, advances took place in their management. The waste can be applied (directly or after prior processing) on the soil to serve as fertilizer. Waste can be processed in digesters, aiming at producing energy, as well as to reduce environmental impact. Analysis of the linkages between intensity, autonomy and nutriment use efficiency is essential to develop sustainable production systems. Despite knowing of the existence of all these practices and concerns, we do not have a method of assessing the effects of such practices, whether at regional or national level. In other words, we have no indicators of whether the Brazilian agriculture and livestock production is actually moving towards higher levels of sustainability. The objective of this paper is to bring some initial insights about the issue, highlighting the potential for further research in the area.

LITERATURE REVIEW

Crop-livestock production systems are the largest cause of human alteration of the global nitrogen (N) and phosphorus (P) cycles (Bouwmana et al., 2013). Nitrogen is a key element controlling the species composition, diversity, dynamics, and functioning of many terrestrial, freshwater, and marine ecosystems. Although most nitrogen inputs serve human needs such as agricultural production, their environmental consequences are serious and long term (Vitousek et al., 1997). The overuse of fertilizers can contribute to contamination of soil and watercourses nitrate, soil acidification and carbon dioxide, nitrous oxide (N_2O) and ammonia to the atmosphere (Lana, 2009). The nitrate pollution has been a current concern in Europe and North America. Animal husbandry results in considerable emissions of ammonia (NH_3), methane (CH_4) and nitrous oxide (N_2O). NH_3 emissions cause eutrophication and acidification and thus play an important role in the decline of biodiversity and dying of forests (Amon et al., 2006).

Agricultural demand during the last 75 years has also increased global P mobilization by roughly fourfold. Much of this P has ended up in soil and natural waters, causing costly eutrophication problems (Childers et al., 2011). Although phosphorus does not imply direct risk to human health - and its concentrations found in the water bodies are much lower than those of nitrate -, it has an essential role in the eutrophication of rivers and lakes, since the addition of this nutrient promotes algae growth and accumulation of organic matter. This phenomenon has direct consequences for other water quality parameters such as BOD (Biochemical oxygen demand) increasing. Nowadays, fertilizer production accounts for 80% to 90% of the worldwide demand for phosphate rock. Beyond P losses at the point of farm production, about 55% of the P in food is lost to inefficiencies "between farm and fork," including wastes in processing, transportation, and storage (Cordell et al., 2009). The world's phosphate reserves that can be explored at low cost are sufficient for 40 to 100 years (Herring & Fantel, 1993; Roberts & Stewart, 2002; Lana, 2009).

The importance of manure as a source of recycled nutrients (N, P) has been recognized for millennia (Russelle, 2007). Alternative management of livestock production systems shows that combinations of intensification, better integration of animal manure in crop production, and matching N and P supply to livestock requirements can effectively reduce nutrient flows (Bouwmana et al., 2013).

Brazil is the fourth largest consumer of nutrients for the formulation of fertilizers, representing about 5.9% of global consumption, behind China, India and the United States. The country imports over 70% of the fertilizer it needs, setting a strong external dependence. Brazilian domestic consumption of fertilizers is concentrated in some cultures, mainly soybeans and corn, which together represent more than half of domestic demand (Inacio, 2013).

One of the major issues for assessment of the long-term sustainability is related to the concept of material and energy use efficiency. To produce such an assessment at multiple scales (from the farm, through the territory and region), one must first identify and quantify the types of materials used, and the impacts associated to these uses. Material Flow Analysis (MFA) is directly related to how the material circulates and how it is transformed within a territory (Smaranda, 2013), and this depends heavily on the technical systems and their articulation in space and time (land use, livestock density, integrating livestock with cropland etc.).

Material flow analysis (MFA) enables the assessment of a system's material consumption for a certain period. It allows the evaluation of trends in material consumption of the economic system through the development of time series. The method can help decision makers to understand the metabolism of a region. MFA examines the materials flowing into certain system (household, company, economic sector, geographical region, etc.), the stocks and flows within this system, and the resulting outputs from the system to other systems (export, wastes, etc.). The MFA method has been applied in research generically known as "territorial metabolism". Such assessments are predominantly devoted to urban areas (Wolman, 1965; Hendriks et al., 2000; Hammer et al., 2006; Barles, 2010; Zhang, 2013), due to the dependence that such locations have in the consumption of materials and energy from other regions. The Eurostat Methodological Guide states that alternative terms such as "industrial metabolism" (Ayres, 1989) or "societal metabolism" (Fischer-Kowalski & Haberl, 1993) have been suggested. The guide postulates that such terms metaphorically consider modern economies as living organisms with a characteristic "metabolic profile" (Eurostat, 2001).

The applications of MFA to assess territorial metabolism focusing in farming systems and food systems have emerged more recently. Billen et al. (2009) examine how the city of Paris has grown up in parallel with the development of its surrounding rural landscape over the long time scale of the last Millennium. Since nitrogen is an essential constituent of the human diet as well as the most limiting factor in agricultural production in temperate regions, the authors elected to describe the exchanges between the countryside and the city in terms of nitrogen flows. Chatzimpiros & Barles (2010) provided an original account of the long-term regional metabolism (for Nitrogen, land and water) in relation to the cattle rearing in western France at three key dates of the 19th, 20th and 21st centuries.

CONCLUSIONS

The development of methods and indicators of assessing whether the Brazilian livestock sector is actually moving towards higher levels of sustainability is required. Material flow analysis (MFA) may be one possibility, once it allows the evaluation of the materials flowing into certain system and territory, the stocks and flows within this system, and the resulting outputs from the system to other ones, as export and wastes.

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