Assessment of the Balance between Livestock Effluent Production and Nutrient Demand by Crops in a Small Agricultural Area of Réunion Island

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Figure 1. Study area of Petit Tampon and Grand Tampon. In the foreground permanent grasslands and in the background the sugarcane-field and the Indian ocean

Recycling livestock effluents can be an interesting way for improving the sustainability of livestock farms as far as it is based on agronomical reasoning. In the Reunion Island, these effluents represent the main source of organic matter and their recycling is a true challenge for the island's agriculture in order to minimize the risks of water and soil pollution and harmful effects. In the Southern part of the island (e.g., in 'Petit Tampon' and 'Grand Tampon'. Figure 1) significant and diversified livestock farming (pigs, poultry, dairy, suckling and fattening cattle) is found together with diversified crop systems (sugarcane, fruit crops, market gardens, and grasslands). The current farmers' practices exhibit management drawbacks: on the one hand effluent recycling on crops is badly developed, generating pollution and harmful effects, whereas on the other hand the requirements of crops in organic fertilisers remain unsatisfied. Until now no agronomic diagnosis had been carried out in this area at the geographical scale in order to assess the adequacy between the crop requirements and the supply of livestock effluents. This baseline study fills this gap, which is essential to allow us to consider possible transfers of organic matter between farms. The aim of this work is to present the method which we implemented to achieve this diagnosis.

Material and methods

Usually, the balance between supply and demand is simply given by the difference between the amount of nitrogen in the livestock effluents produced and the crops requirements in nitrogen (Figure 2).

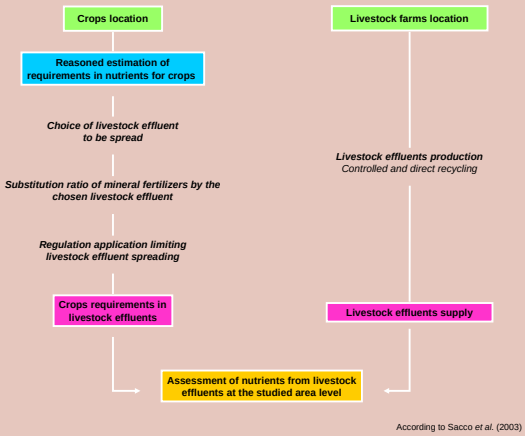

Figure 2. Method for the assessment of the balance between livestock effluents production and nutrient demand by crops

The originality of our approach lies in the method used for calculating the nutrient requirements by the crops. This approach is based on the reasoned fertilization principle using the nitrogen efficiency equation (Muller *et al.,* 2001) in a tropical area with a strong altitudinal gradient. Calculation at the plot scale is based on the effective supply of endogenous nitrogen by the soil and the nitrogen efficiency ratios of fertilizer applications (apparent fertilizer use ratio and equivalent fertilizer ratio) experimentally measured. The plot data (crops, expected yield, nitrogen supply from soils, nitrogen efficiency ratios) were stored in a database allowing us to calculate the crop requirements at the plot scale. This calculation was carried out according to allocation rules of effluents to crops, the relative part of mineral fertilizers in the total nitrogen fertilization, and the type of spreading regulations holding in France. This last option coupled with a GIS allowed us to define the net spreading area of a plot and thus to adjust the crop requirements as well as possible.

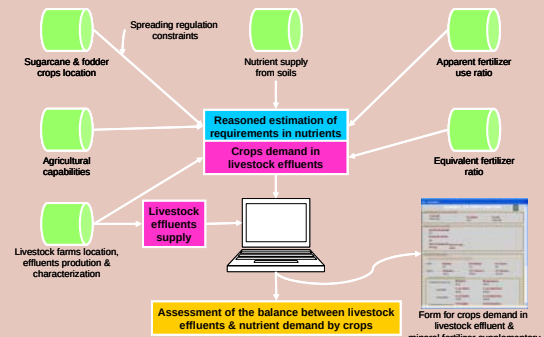

Figure 4. Organization of the calculation tool of the crops requirements and of the assessment of the balance between livestock effluents and nutrient demand by crops

Results and conclusions

According to the inventory of nutrients stemming from livestock production (57.500 kg of nitrogen), the determination of crop requirements and the cartography of the spreading areas of the agricultural land, it appeared that the Petit Tampon and Grand Tampon area could recycle all nitrogen from the solid manure. With regard to liquid manure, the results lead us to establish two diagnoses according to the spreading regulations that should apply to the livestock farms: If it was assumed that the livestock farms comply with the French 'Réglement Sanitaire Départemental' (*i.e.,* general constraints on spreading), then surpluses were found. If it was assumed that all the livestock farms comply with the French 'Installations Classées pour la Protection de l'Environnement' regulation, then be substitution of 66% of mineral fertilizer needs with organic fertilizers it would be possible to recycle all nitrogen produced in the area (Figure 3). In addition to this diagnosis, this work enabled us to devise, with Microsoft Access, a calculation tool of the crops requirement using a generic form of request. This tool was built to be used by agricultural advisers (Figure 4).

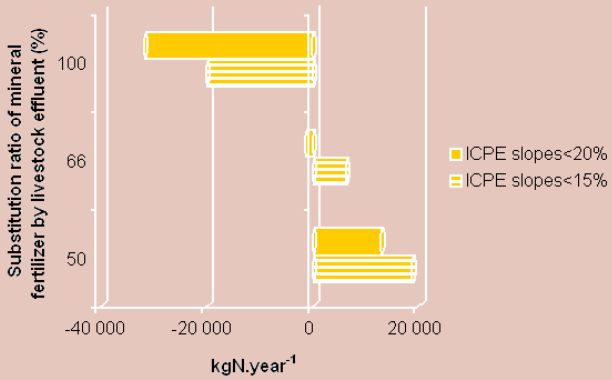

Figure 3. Livestock effluent mass balances (kg of nitrogen per year) for the studied area of 'Petit Tampon' and 'Grand Tampon' according to the French 'Installations Classées pour la Protection de l'Environnement - ICPE' regulation. The levels of substituting mineral fertilizers were evaluated, *i.e.* 50, 66 and 100%

Prospects

This global diagnosis will be completed by diagnoses to be made within individual farms in order to determine possible difficulties of effluent management at the farm scale. These farm diagnoses should also enable us to use flow simulation models in order to design more efficient effluent management strategies in association with the agricultural stakeholders of the area.

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