Comparative assessment of different cow manure valorisation technologies from an environmental perspective

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Abstract

During the last decades, the increasing concern about the environmental sustainability, especially in terms of natural resources consumption and intensive agro-livestock practices, is widely recognised (Steinfeld *et al.*, 2006; Roy *et al.*, 2009). In this context, the production of energy from renewable sources (bioenergy) plays a crucial role (Benoist et al., 2012). This is mainly due to the production of biogas as well as the generation of digestate, used for organic fertilisation purposes (Abubaker et al., 2012; Benoist *et al.*, 2012). Moreover, livestock sector produces an important source of organic carbon and untapped nutrients whose direct use is restricted due to their negative environmental consequences (Steinfeld *et al.*, 2006). Accordingly, there is an increasing interest in translating a quantitative waste problem into an important recovery and reuse opportunity (Notarnicola *et al.*, 2012). In this sense, the goal of this study was to compare the environmental burdens related to different alternative scenarios focussed on cow manure treatment technologies through a Life Cycle Assessment (LCA) perspective (**Figure 1**): (a) direct application of cow manure as organic fertiliser, (b) anaerobic co-digestion of cow manure together with other organic sources (energy crops and agro-food waste) and (c) anaerobic co-digestion of cow manure and other organic waste (energy crops and agro-food waste) followed by solid-liquid separation. Both further use of recovered nutrients as organic fertilisers and renewable energy production from biogas stream obtained in anaerobic digestion were also taken into consideration. The following impact categories were considered for assessment in accordance with literature: climate change, terrestrial acidification, freshwater eutrophication, marine eutrophication, water depletion and fossil depletion. The characterisation factors reported by the ReCiPe Midpoint (H) 1.12 method were managed and the software SimaPro 8.0.5.3 was used for the computational implementation of the inventories (Goedkoop *et al.*, 2013a,b). On the basis of the results, the most environmentally friendly scenarios were identified. Thus, the Scenarios B and C would present better environmental profiles with lower environmental burdens in comparison with Scenario A. These results can be explained mainly due to the environmental credits derived from the avoided network electricity generation (by means of electricity production in the CHP unit)as well as the avoided mineral fertilisers production and related emissions into air, soil and water.

Moreover, further research would be included involving both economic and social perspectives, with the aim of developing a comprehensive sustainability assessment. For this, the *Weighted Goal Programming* methodology would be used as an interesting support tool for the comparison in a systematic and consistent way of the different alternatives for cattle waste valorisation outlined above.

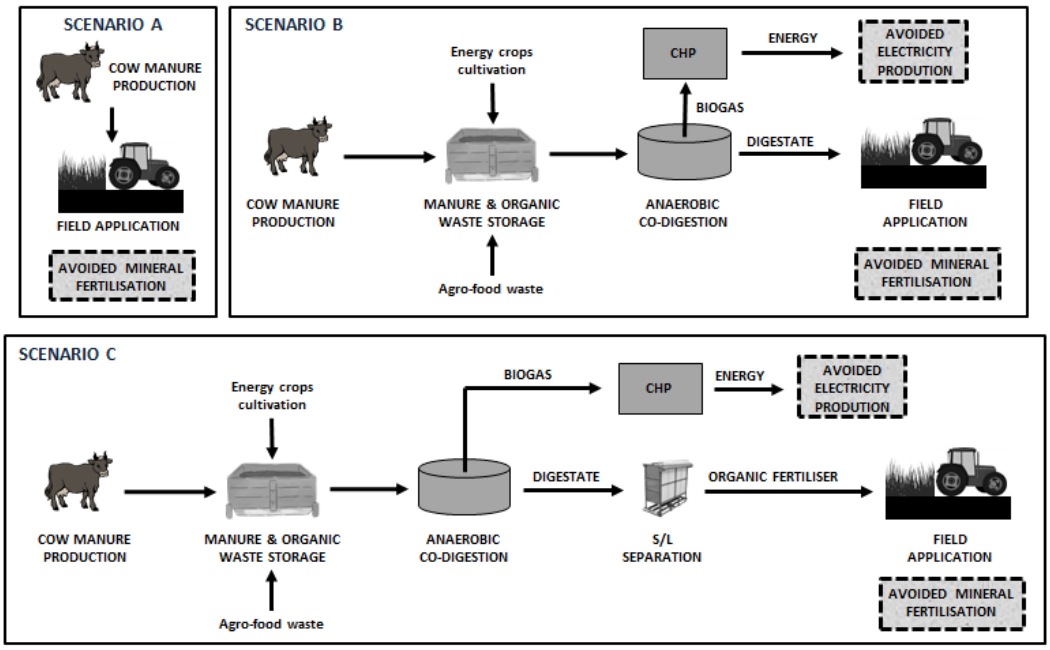

Figure 1. Flowchart of processes involved in the alternative scenarios evaluated (Scenario A, Scenario B, Scenario C).

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