How to account for emissions from manure? Who bears the burden?

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1. BACKGROUND

Manure affects the environment negatively because it causes emissions of ammonia, nitrous oxide, nitrate and phosphate, both during storage and when the manure is applied as fertilizer to field-grown crops. On the other hand manure might also contribute positively to the environment, if it substitutes artificial fertilizer or is used for energy production and thereby substitutes fossil fuel. In an integrated farming system where manure is recycled to feed crops only, it does not matter whether manure emissions are allocated to the pigs or the feed crops, since the environmental burden will be allocated to the pigs in any case. But when manure is used in cash crop production, whether on the pig farm itself or after export to another farm, then the question of allocation of emissions from handling manure arises. In order to facilitate comparisons of LCAs on food items it is important to have clear and transparent methods, and –ideally- to agree on a standard method. The following paper will present a practical example with demonstration of the method applied in the Danish LCAfood database (www.LCAfood.dk).

2. OBJECTIVE

The objective is to establish a framework for handling livestock manure in LCA, and thereby give answers to the following question: How to account for emissions from manure in an LCA of livestock products? Shall the environmental impact from manure be ascribed to the pig or the cash crops to which the manure is applied?

3. METHODOLOGY

Our conceptual choice is that all extra emissions arising from using livestock manure in cash crop production should "burden" the environmental profile of the livestock products. On the other hand, this environmental cost should be deducted any saved emissions arising in the cash crop production from replaced fertiliser. Thus, we follow principles of using systems expansion for handling of co-products in LCA [1].
Consequential LCA modelling was performed, thus including the manure related emissions on the cash crop farm and the avoided production of artificial fertilizer. Calculation of the emissions from stable, storage and filed was based on Dalgaard et al. (2006) [2]. The amount of avoided artificial fertilizer is based on data from the Danish Environmental regulation. The Danish regulation stipulated that for each 100 kg of N applied in pigmanure to a crop the fertiliser should be reduced by 60 kg N compared to the public norm for the particular crop on the particular soil type.

The second methodological choice was that if the manure was used for biogas production, the net benefit in terms of avoided CO_2 emissions –and any other avoided emissions- were deducted from the environmental assessment of the pig products.

4. RESULTS AND DISCUSSION

The inventory and characterized results per kg manure N exported from a pig farm to a cash crop farm is presented in figure 1. Each kg manure N exported from the farm results in an avoided production of 0.6 kg N artificial fertilizer, and extra emissions of N and fossil CO_2. Using manure on cash crops instead of fertiliser in cash crops creates more emissions of Nitrogen (ammonia, nitrous oxide and nitrate) contributing to several environmental impact categories. It does not seem satisfactory to leave this as an extra burden on the cash crops. The method presented takes as a starting point that these emissions should burden the livestock products, but only after a proper systems expansion model has been established. The paper has presented how this may be done relatively easy. Due to the strict and detailed Danish regulations for the proportion of fertiliser N to be replaced by manure N there was a transparent reference for calculation of the avoided CO_2 and N emissions from saved fertiliser. In countries where this is not the case there is a need to develop an approach building on representative data re. the degree of fertiliser replacement from manure in the farming systems in question.

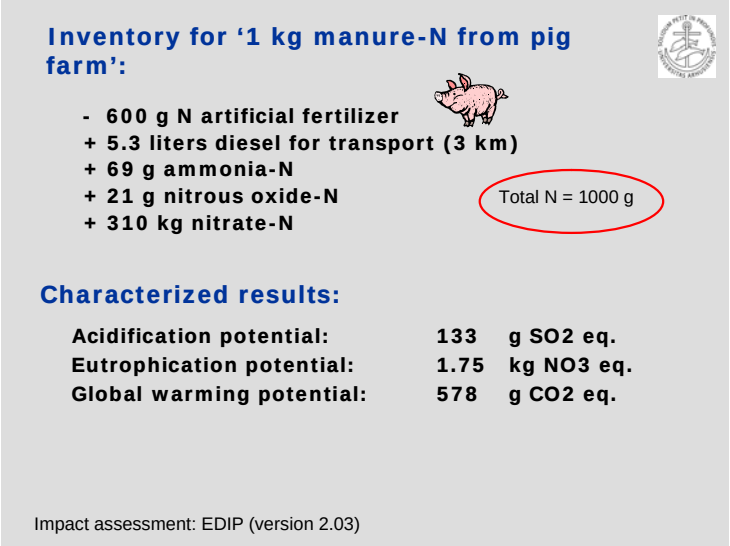

Figure 1. Inventory and characterized results of one kg manure-N exported from a pig farm to a cash crop farm. under Danish conditions.

5. CONCLUSION

The method is easy to apply and gives a coherent methodological alternative to simple (or no) allocation. Both the drawbacks (emissions from stable, storage, fields, transport) and the benefits (e.g. avoided production of artificial fertilizer and fossil energy) must be included. The pig bears the burden from the manure related emissions on the cash crop farm, but the pig also benefits from avoided production of artificial fertilizer and fossil energy.

6. REFERENCES

1. Weidema B (2003): Market information in Life Cycle assessment. Environmental Project No. 863. Danish Ministry of the Environment. Environmental Protection Agency. Available at: http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/publications/2003/87-7972-991-6/html/default_eng.htm

2. Dalgaard, N. Halberg, I.S. Kristensen and I. Larsen
Modelling representative and coherent Danish farm types based on farm accountancy data for use in environmental assessments**.** Agriculture, Ecosystems & Environment, 117: **223-237, 200**