

Influence of the farm size on the uncertainty of milk life cycle inventory data

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Introduction

Life Cycle Assessment (LCA) has proven to be a valuable tool to document and analyse environmental considerations of product and service systems that need to be part of the decision-making process towards sustainability¹. The first definition was established in 1993 as follows: an LCA is “a process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released into the environment; to assess the impact of the energy and materials used and released into the environment; and to identify and evaluate opportunities to affect environmental improvements”².

This complete analysis, also called “from the cradle to the grave”, has been used since the end of the seventies to analyse a huge number of products and processes: food industry points out as an important sector among them. In particular, milk has been studied in different countries within this complete perspective^{3,4,5} and farms have been found to be responsible for a high percentage of the environmental load of the total process.

The LCA study related to the Spanish sector was based on the inventory of two representative dairy farms⁵. Now, an expanded inventory has been carried out including seventeen farms with different size and degree of technology in order to improve the quality of the data collected by reducing the uncertainty involved.

Data collection

With the aim of gathering data systematically, a questionnaire was defined and distributed among farmers. At the survey, the questions were grouped in seven items:

- 1) General data: localization and degree of technology
- 2) Farm size, both animals and hectares
- 3) Animals' life, housing and grazing hours.
- 4) Products, milk and meat, obtained at the farm.
- 5) Inputs consumed at the farm: food ration elements, cleaning elements, milking products, electricity and etcetera.
- 6) Waste generated at the farm, including wastewater, manure, municipal solid waste, fractions suitable for recycling.
- 7) Other comments. This is an open space that allows the farmer to include any type of relevant information.

Diverse classification criteria are proposed to group the farms studied:

¹ UNEP-DTIE (2003): Evaluation of environmental impacts in life cycle assessment. United Nations Environment Programme; Division of Technology, Industry and Economics, Borghetto Lodigiano.

² Consoli, F. (1993): Guidelines for Life Cycle Assessment: A code of practice. SETAC, Sesimbra.

³ Hogaas, M. E. (2002): Life Cycle Assessment of Industrial Milk Production. *Int J LCA* 7 115-126.

⁴ Cederberg, C., Mattson, B. (2000): Life cycle assessment of milk production - a comparison of conventional and organic farming. *J Cleaner Production* 8 49-60.

⁵ Hospido, A., Moreira, M. T., Feijoo, G. (2003): Simplified Life Cycle Assessment of Galician Milk Production. *Int Dairy J* 13 783-796.

- a) By size, where six segments are presented
- b) By technology degree, distinguishing low, medium, high and very high
- c) By feeding regimen, where internal based regimen (maize and silage) and external based regimen (fodder) are distinguished.

Incidence of the farm's size

Since the nineties, Galician farmers can join voluntarily to a system of milk control that, nowadays, is taking care of around 1500 facilities⁶.

The figure shows the established distribution of the farmer based on size and milk quota. On the one hand, it can be observed that the first group (less than 15 heads) is the most numerous; however its influence on the productive framework is almost negligible. On the other hand, the “41-70 heads” segment is the most important as far as milk quota is concerned although it stands for the third position at the numbers of facilities.

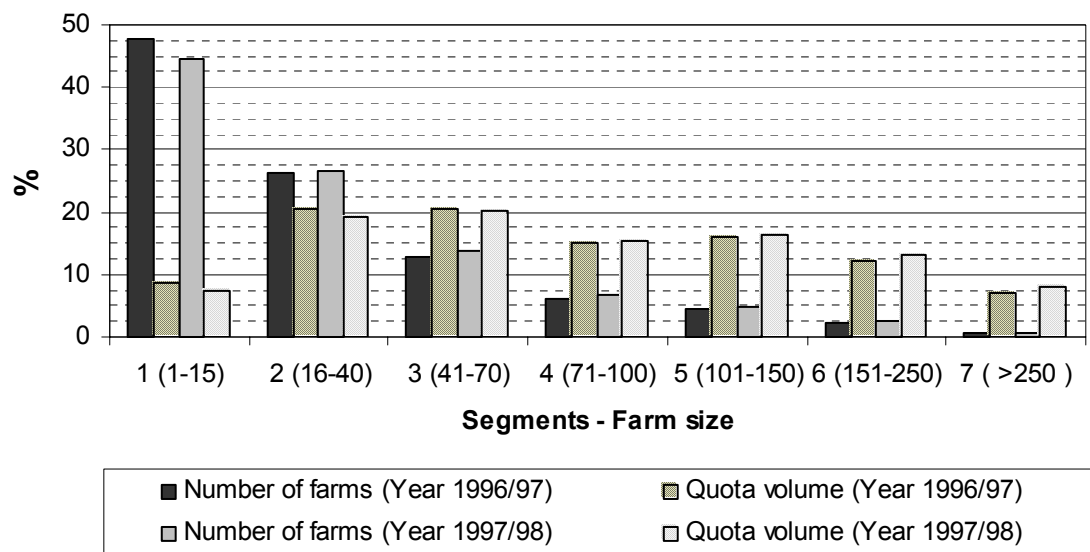


Figure 1. Perceptual distribution of farms according to size and milk quota

Table 1. Assignment of the inventoried farms

| | Size (total number of cows) | Segment |
|---------|-----------------------------|---------|
| Farm 1 | 50 | 3 |
| Farm 2 | 60 | 3 |
| Farm 3 | 67 | 3 |
| Farm 4 | 105 | 5 |
| Farm 5 | 33 | 2 |
| Farm 6 | 125 | 5 |
| Farm 7 | 107 | 5 |
| Farm 8 | 108 | 5 |
| Farm 9 | 97 | 4 |
| Farm 10 | 34 | 2 |
| Farm 11 | 23 | 2 |
| Farm 12 | 23 | 2 |
| Farm 13 | 18 | 2 |

⁶ Barbeyto, F. (1993, 1996, 1997): Explotacións de vacún de leite en Galicia. Manexo técnico e resultados económicos. Xunta de Galicia, Santiago de Compostela. [In Galician]

| | | |
|---------|-----|---|
| Farm 14 | 170 | 6 |
| Farm 15 | 33 | 2 |
| Farm 16 | 41 | 3 |
| Farm 17 | 104 | 5 |

Results and Discussion

Holstein Frisian is, undoubtedly, the most common breed in Galicia (Table 2). Pérez-Cabal and Alenda⁷ have studied thoroughly its productive characteristics and they have quantified the average yield in 8262 litres per year. This figure is very close to the value obtained from the farms that have been inventoried in this study (8682 litres per year); however, it is necessary to mention that individual values vary a little (Figure 3).

Table 2. Evolution of Holstein Frisian breeds in Galician dairy herds⁸

| | 1993 | 1995 | 1997 | 1999 | 2000 |
|------------|---------|---------|---------|---------|---------|
| Dairy Cows | 501 621 | 447 067 | 505 143 | 424 396 | 446 257 |
| Frisian | 400 529 | 397 862 | 436 826 | 409 947 | 427 635 |
| % | 79.85 | 88.99 | 86.48 | 96.60 | 95.83 |

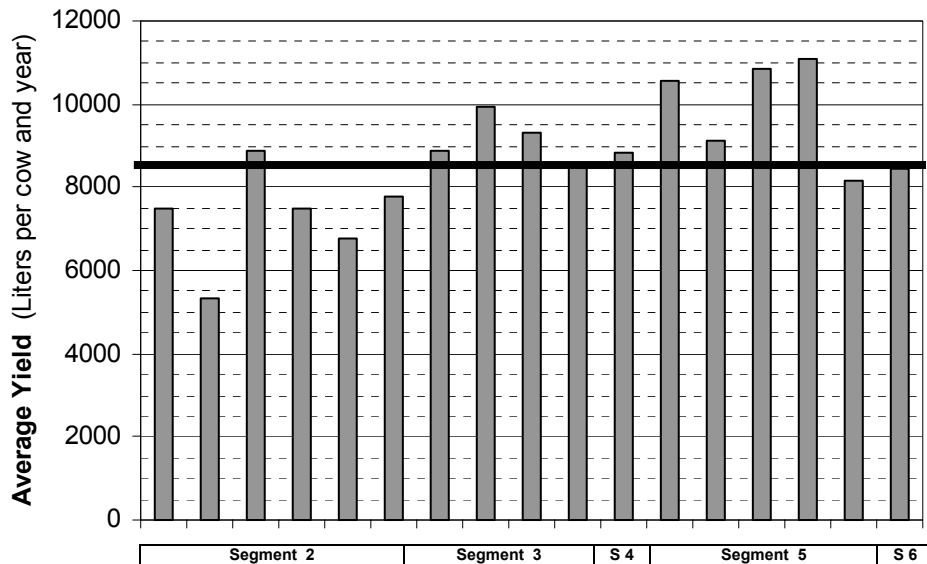


Figure 2. Average yield variation according to farm size

It can be pointed out that values from farms of Segment 2 (all except one) are below the average value as was expected. However, an odd result is that the two bigger farms (125 and 170 cows, respectively) are also located under that threshold value.

The inventory data collection carried out has shown that a standard pattern of working at Galician dairy sector does not exist. On the contrary, each farmer exploits the smallholding on the basis of the available resources and looking for the maximum profit. As a consequence, variability at collected data is very high and the aim of this study is to analyse if the farm size is a significant parameter in relation to this unevenness.

⁷ Pérez-Cabal, M. A., Alenda, R. (2002). Genetic relationship between lifetime profit and type traits in Spanish Holstein Cows. *J Dairy Sci* 85 3480-3491.

⁸ Instituto Galego de Estadística (Galician Institute of Statistics), www.ige.xunta.es (2003). [In Galician]

Inputs to the System

As far as inputs are concerned, the most important variability has been found at food ration, which definition and preparation depends on two key aspects:

- a) the desired productive yield per cow
- b) the availability and quality of internal elements, that is to say, those that are produced at farm such as maize and silage

Results from the analysis of these components are displayed at Figure 3.

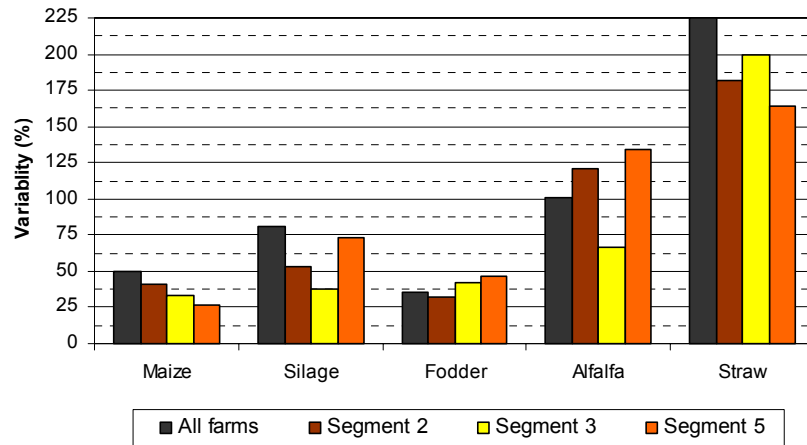


Figure 3. Variability of the food components

As it can be observed, there is no clear behaviour, although variability at maize and silage is reduced when farms are grouped.

Even when the same irregular tendency appears at comparison of total consumptions (Figure 4), some comments can be derived:

- a) Bigger farms based the food ration on maize
- b) Food at smaller farms is focused on silage, specially farms from segment 2

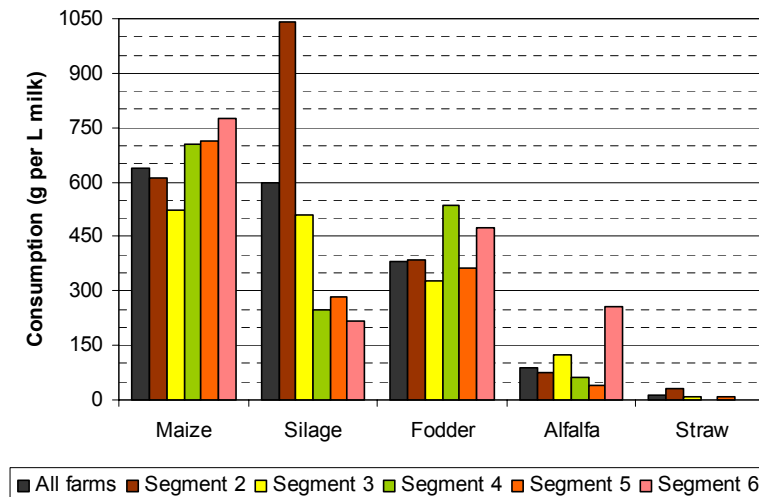


Figure 4. Average consumptions of food according to the segmentation

Concerning items related to milking activities, the same analysis supplies us with the same type of result (Figures 5 and 6). In the view of the average consumptions, segment 2 seems to

be the less efficient one with values over the global average number (the only exception is the disinfectant).

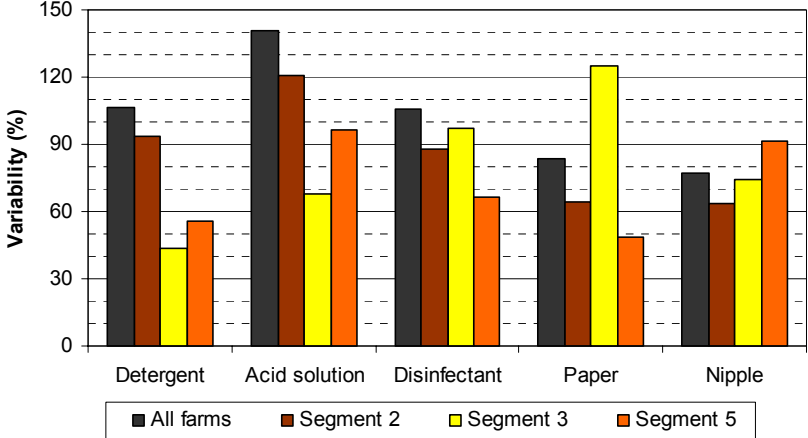


Figure 5. Variability of the milking products

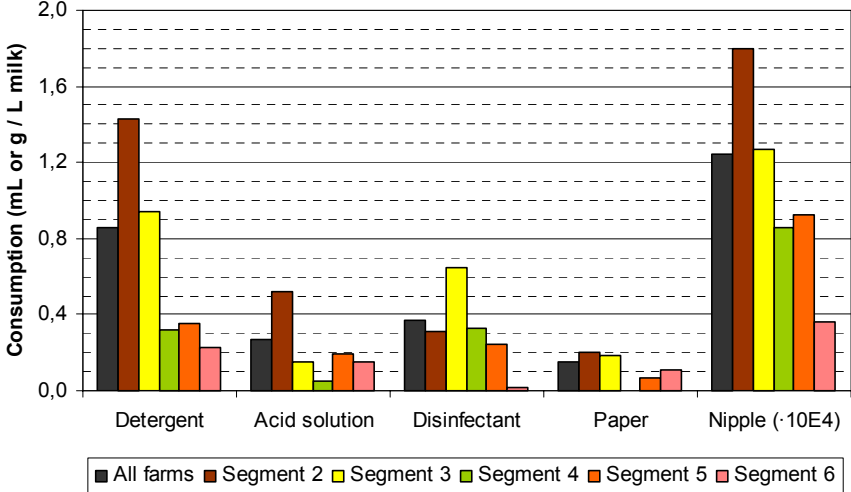


Figure 6. Average consumptions of milking products according to the segmentation

The last group of data are the general inputs such as electricity and fuels and it can be observed that variability decreases slightly when segmentation takes place (Figure 7). Moreover, also in this case, the average consumptions per litre of milk produced are higher at the smaller farms (Figure 8).

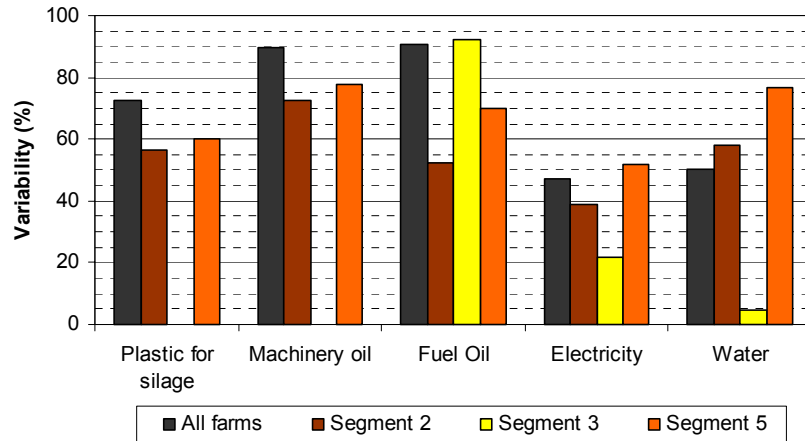


Figure 7. Variability of general inputs

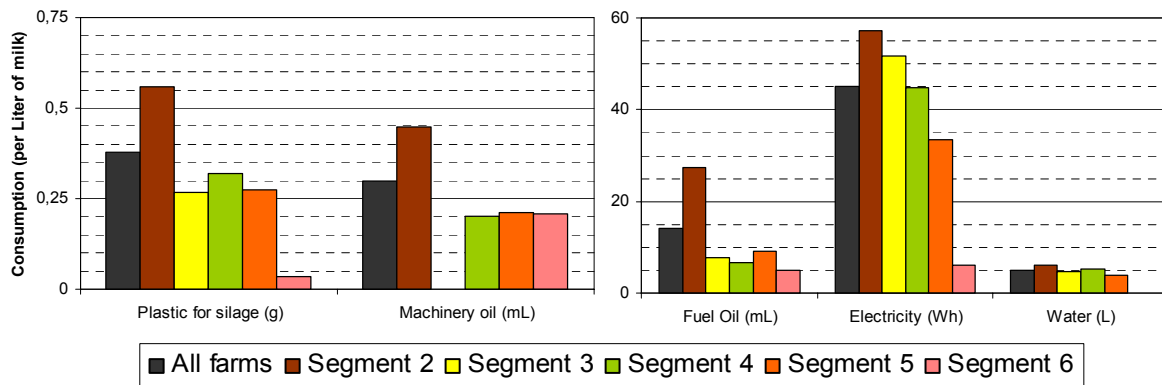


Figure 8. Average consumptions of general inputs according to the segmentation

Outputs to the System

The functional unit has been defined as 1 litre of raw milk ready to be delivered to the dairy. As a consequence this parameter does not present variability.

Nevertheless, milk is not the unique product that can be obtained from a cow. In fact, meat is also produced and it should not be disregarded. Data handled here are not accurate enough as farmers deal with surplus calves and all animals in different ways.

The same reason, not available data, waste generation can not be considered. In Galicia, farmers are not aware regarding environment and pollution, so the quantification of municipal solid waste and other types of special residues such as medicines or residual plastic for silage is not possible at the present time.

Conclusions and Outlook

Taking into account all the figures presented here, no general conclusion can be obtained; however, in certain aspects this grouping may help in the determination of average values of consumption.

In this sense, E. Audsley⁹ has pointed out the necessity of the definition of a farm typology which allows a standardised modelling of the data collection, as conclusive results from the

⁹ Audsley, E. (2000): Systematic procedures for calculating agricultural performance data for comparing systems IN Agricultural data for Life Cycle Assessments, The Hague.

study of individual facilities can derive in high uncertainties. Poppe and Meeusen¹⁰ propose the use of Accountancy Data to a better quantification of the inputs of a LCA Study.

ACKNOWLEDGEMENTS

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¹⁰ Poppe, K. J., Meeusen, J. G. (2000): Using a Farm Accountancy Data Network in data management for LCA IN Agricultural data for Life Cycle Assessments, The Hague.