

# Environmental Impact Assessment of an Armenian Dairy using Life Cycle Assessment Methodology

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## Abstract

*Dairy industries create various environmental impacts, such as water and energy consumption, and production of waste water, atmospheric emissions and solid wastes [7, 9]. According to previous (European) studies, the environmental impacts of dairies are usually neglected, especially at the processing level. Therefore, there is a necessity for a thorough evaluation of the environmental impacts of milk processing with a special focus on the “processing” and “packaging” stages. Due to the fact that Armenia can expect to experience unfavorable consequences of global climate change, sustainable processing, especially in the agriculture sector, would be a useful development goal. Therefore, this study, as a part of a PhD project at the University of Kassel/Germany, aims to analyze and evaluate the environmental impacts of a dairy in Armenia using a developed, adapted Life Cycle Assessment-tool. This paper focuses on the environmental impacts associated with the processing of raw cow’s milk to packaged milk, cheese, yogurt, and ayran in a dairy working according to organic standards in Yerevan. The results should indicate the current situation of milk processing in the Republic of Armenia and provide a basis for effective governmental anti-pollution legislation.*

## Introduction

The Republic of Armenia is a party-signatory of the Kyoto Protocol and the first country that began to sell quotas for greenhouse gas emissions. It is estimated that by 2100, the average air temperature in Armenia will have increased by 1.7°C, and the precipitation will have decreased by about 10% as a result of global climate changes [3]. The Armenian industry is one of the sectors which are required to reduce emission levels, such as those of CO<sub>2</sub> [3]. In this connection, however, the environmental impacts of dairy industries, such as water and energy consumption, as well as production of waste water, atmospheric emissions, and solid wastes, are usually neglected, especially at the processing level [2, 4, 5,6,8]. Therefore, this study aims to analyze and evaluate the environmental impacts of the milk processing sector in Armenia using the Life Cycle Assessment methodology.

Life Cycle Assessment (LCA) is a tool for environmental management by which the environmental impacts associated with a product are assessed. The assessment of environmental aspects covers the whole life cycle of the product [1, 10].

## Methodology

The methodology, which will be used in this study is LCA according to ISO 14040 (principles and framework) and ISO 14044 (requirements and guidelines) standards. The support software to be used in this study is SimaPro 7, the PhD version [10]. Hence, this study will have the following steps:

### Defining goal, scope and approach

The goals and objectives of this study are to

- analyze and assess the environmental impacts of an organic dairy in Yerevan/Armenia associated with the processing of raw cow's milk to packaged milk, cheese, and two sour milk products (yogurt, ayran),
- compare the results with the results of the similar European LCA studies (organic and conventional),
- identify the dairy processes with the largest environmental impacts,
- determine the contribution of dairy industries to the global climate changes in Armenia, and consequently
- suggest of system improvement options to reduce the environmental impacts and save energy and natural resources.

The boundaries of this system include only the stages "processing of raw cow's milk" to the dairy products mentioned above and the packaging of the final products. The levels "production of raw cow's milk", "transport of the final products to the final consumers", "consumption of final products" and "final deposition" will be excluded from this study.

Recognizing the "hot spots" in each stage of product's life cycle (here the processing and packaging stages) makes the environmental improvements easily achievable, namely suggestion of process improvement options to and applying of processes and methods which save energy and natural resources, etc. Therefore, the picture of the total environmental performance of milk processing in the Republic of Armenia can be an initial step in the improvement of environmental management in relation to dairies.

#### Life Cycle Inventory (LCI)

In the inventory phase, all inputs and outputs, which occur during every raw milk process, and packaging of final products, will be determined. The input/output data is going to be collected by measurements, interviews and database searches. Consequently, this data will be computed as an inventory table. It is intended to analyze the impact categories "Global Warming Potential" (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), "Acidification Potential" (NH<sub>3</sub>, NO<sub>x</sub>, SO<sub>x</sub>), and "Eutrophication Potential" (NO<sub>3</sub><sup>-</sup>, NH<sub>3</sub>, NO<sub>x</sub>, PO<sub>4</sub><sup>3-</sup>) by this study.

#### Life Cycle Impact Assessment (LCIA)

In the LCIA the environmental impacts collected in the inventory will be systematically evaluated. The impact assessment method to be used in this study is the Eco-indicator 99, which will be developed and adapted to the Armenian dairy.

#### **Expected results**

It is expected that there will be a large number of parameters for the impact categories. For this reason, only the most significant parameters will be considered. It is assumed that the impact categories and parameters to be analyzed will be "Global Warming Potential" (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), "Acidification Potential" (NH<sub>3</sub>, NO<sub>x</sub>, SO<sub>x</sub>) and "Eutrophication Potential" (NO<sub>3</sub><sup>-</sup>, NH<sub>3</sub>, NO<sub>x</sub>, PO<sub>4</sub><sup>3-</sup>). It is also predicted that the cheese production will have the largest CO<sub>2</sub> emissions, followed by the production of packaged milk. CO<sub>2</sub> will probably account for the largest atmospheric emission of the raw milk processing, followed by CH<sub>4</sub>. The production of packaged milk will probably create, in addition, a large amount of NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup>, and NO<sub>x</sub>. Yogurt and ayran production are expected to show the lowest emissions. Thus, both sour milk products will probably contribute least to global warming, acidification, and eutrophication. The production of packaged milk and of cheese will supposedly contribute most to the categories mentioned above.

The environmental evaluation of the Armenian dairy sector with a special focus on the “processing” and “packaging” stages could be an opportunity to advise producers, scientists, and authorities on the dairy industries’ emissions. From this study, the raw milk processes with the largest environmental impacts can be identified and the contribution of dairy industries to global climate changes in Armenia can be determined. The results may be used for the organization of a dairy that meets organic standards. The environmental impact assessment of raw milk processing will include various environmental parameters, and may be used to inform national agrarian and environmental legislations in the Republic of Armenia.

## References

- [1] **Anderson, K., T. Ohlsson, and P. Olsson (1994):** Life cycle assessment (LCA) of food products and production systems. *Trends in Food Science & Technology* 51: 34- 38.
- [2] **Casey, J. W., and N. M. Holden (2004):** A systematic description and analysis of GHG emissions resulting from Ireland’s milk production using LCA methodology. DIAS report. Life Cycle Assessment in the Agri-food sector. *Animal Husbandry* 61: 219-225.
- [3] **CCArmenia (1996):** Climate Change Information Center of Armenia. Consequences of climate change in Armenia. <http://www.nature-ic.am/ccarmenia/en/?nid=69>
- [4] **Cederberg, C., and B. Mattsson (2000):** Life cycle assessment of milk production – a comparison of conventional and organic farming. *Journal of Cleaner Production* 8: 49-60.
- [5] **De Boer, I. J. M. (2003):** Environmental impact assessment of conventional and organic milk production. *Livestock Production Science* 80: 69-77.
- [6] **De Boer, I. J. M., G. Iepema, and M. A. Thomassen (2004):** Environmental Impact Assessment at Commercial Dairy Farms. DIAS report. Life Cycle Assessment in the Agri-food sector. *Animal Husbandry* 61: 214-218.
- [7] **Hospido, A., M. T. Moreira, and G. Feijoo (2004):** Life Cycle Inventory of the Galician dairy sector. DIAS report. Life Cycle Assessment in the Agri-food sector. *Animal Husbandry* 61: 118-126.
- [8] **Hospido, A., M. T. Moreira, and G. Feijoo (2003):** Simplified life cycle assessment of galician milk production. *International Dairy Journal*, Vol. 13, No. 10: 783-796.
- [9] **Ledgard, S. F., J. D. Finlayson, M. G. Patterson, R. A. Carran, and M. E. Wedderburn (2004):** Effects of Intensification of Dairy Farming in New Zealand on Whole system Resource Use Efficiency and Environmental Emissions. DIAS report. Life Cycle Assessment in the Agri-food sector. *Animal Husbandry* 61: 226-229.
- [10] **Goedkoop, M., A. De Schryver, and M. Oele (2008):** Pré, product ecology consultants, SimaPro 7. Introduction into LCA. <http://www.pre.nl/simapro/manuals/default.htm>