



From analysis to implementation



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Environmental Impact Assessment of the Portuguese Dairy Sector

Castanheira, É. G.¹; Dias, A. C.²; Ferreira A. J. D.¹; Pereira, C. J. D.¹; Arroja, L.²; Carreiras, M.¹

¹ CERNAS, Escola Superior Agrária de Coimbra, Coimbra, Portugal

² CESAM, Departamento de Ambiente e Ordenamento - Universidade de Aveiro, Aveiro, Portugal

What's going on in Portugal

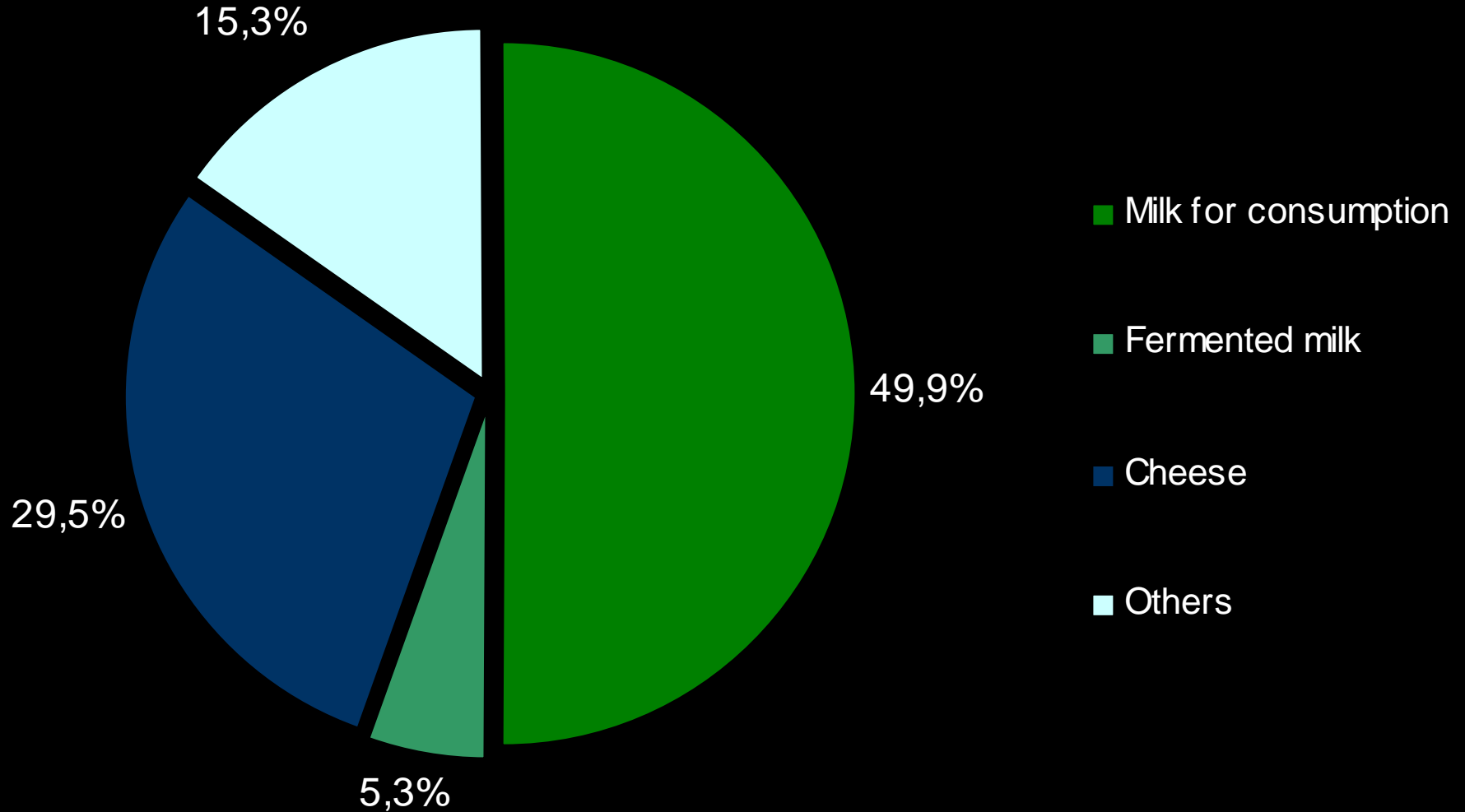
- Dairies industries are characterized by presenting several environmental impacts:
 - high water and energy consumption
 - discharge of wastewater with high organic loads
- Nowadays, in Portugal, it is urgent to carry out:
 - an effective evaluation of the environmental impacts associated to each one of the different productive processes of this sector,
 - an evaluation of the global environmental impact of this sector.



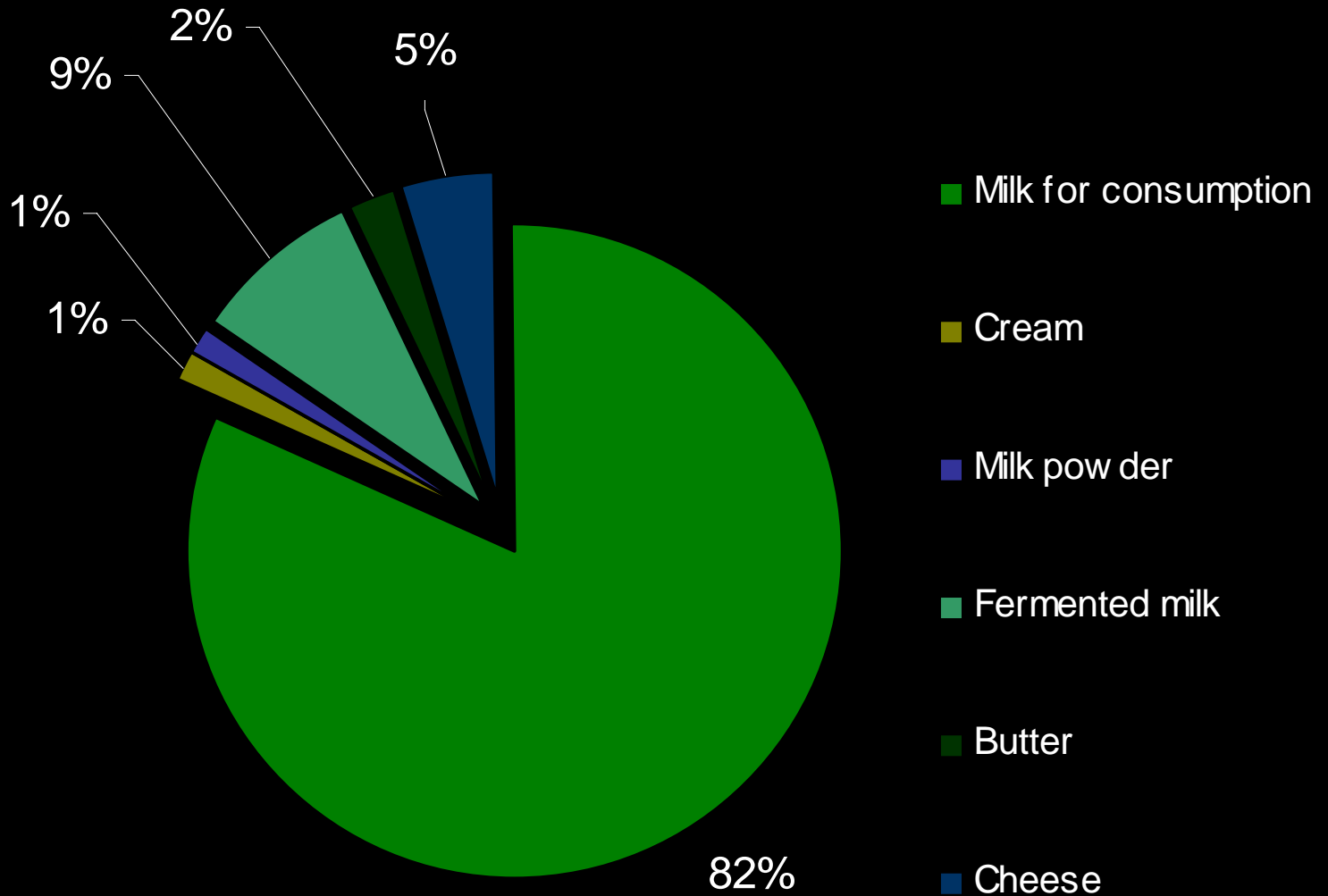
Objective of this study

- This study intends to contribute for this evaluation through the use of life cycle assessment (LCA).
- LCA technique was applied to the Portuguese dairy sector (excluding Azores and Madeira Islands), concretely to the productive processes of milk for consumption, yoghurt and curd cheese from cow milk.
- These products were selected because about 85% of the raw cow milk in Portugal in year 2005 was used in their production.

Raw milk used in products - Mainland Portugal (2005)



Milk products obtained in Mainland Portugal (2005)



Methodology

Goal and Scope definition

- **Goals:**

- to evaluate the environmental impacts associated to the dairy sector in Portugal for the year of 2005,
- to identify the contribution of each one of the different milky products: milk for consumption, yoghurt and curd cheese of cow.

- **Functional unit**

- the amount of raw milk collected from cows, in Mainland Portugal, in 2005, for milk, yoghurt and curd cheese production (1 626 880 tonnes).

Methodology

Goal and Scope definition

- **Borders INSIDE**
 - industrial processing
 - production of raw milk
 - including:
 - the production of chemicals and energy
 - the extraction and processing of fuels
 - wastewater treatment

- **Borders OUTSIDE**
 - use/consumption
 - final deposition of the products
 - packing
 - product transport
 - capital goods production (equipment, buildings)

Methodology

Inventory analysis

- Conception of the flowcharts of the processes
- Compilation of the respective data of inputs and outputs

<i>Life cycle phase</i>	<i>Process</i>	<i>Source</i>	<i>Period</i>	<i>Geographical origin</i>
<i>Raw milk production</i>	Fertilizers	Nielsen et al. (2003)	1999	Denmark
	Animal's food			
	Fuels			
	Energy			
	Transport			
<i>Raw milk processing</i>	Raw milk	INE/ANIL (2006)	2005	Portugal Continental
	NaOH (100%)	Buwal (1996)	1990-1994	Occidental Europe
	Acid solution	Frischknecht et al. (1996)	1990-1994	Occidental Europe
	Thermal energy	Frischknecht et al. (1996)	1990-1994	Occidental Europe
	Electricity from Portugal	Buwal (1996)	1990-1994	Occidental Europe
	Milk, yoghurt and curd cheese production	IPPC (2006)	2002	Europe (medium values)

Data source, period and geographic origin

Methodology

Impact assessment

- Selection of the impact categories,
 - Global Warming for a horizon of 100 years (GW100)
 - Photochemical Oxidation (PO)
 - Acidification (A)
 - Eutrophication (E)
- Classification (the inventory parameters are assigned to each one of the impact categories)
- Characterization (the inventory parameters are affected by characterization factors)

Methodology

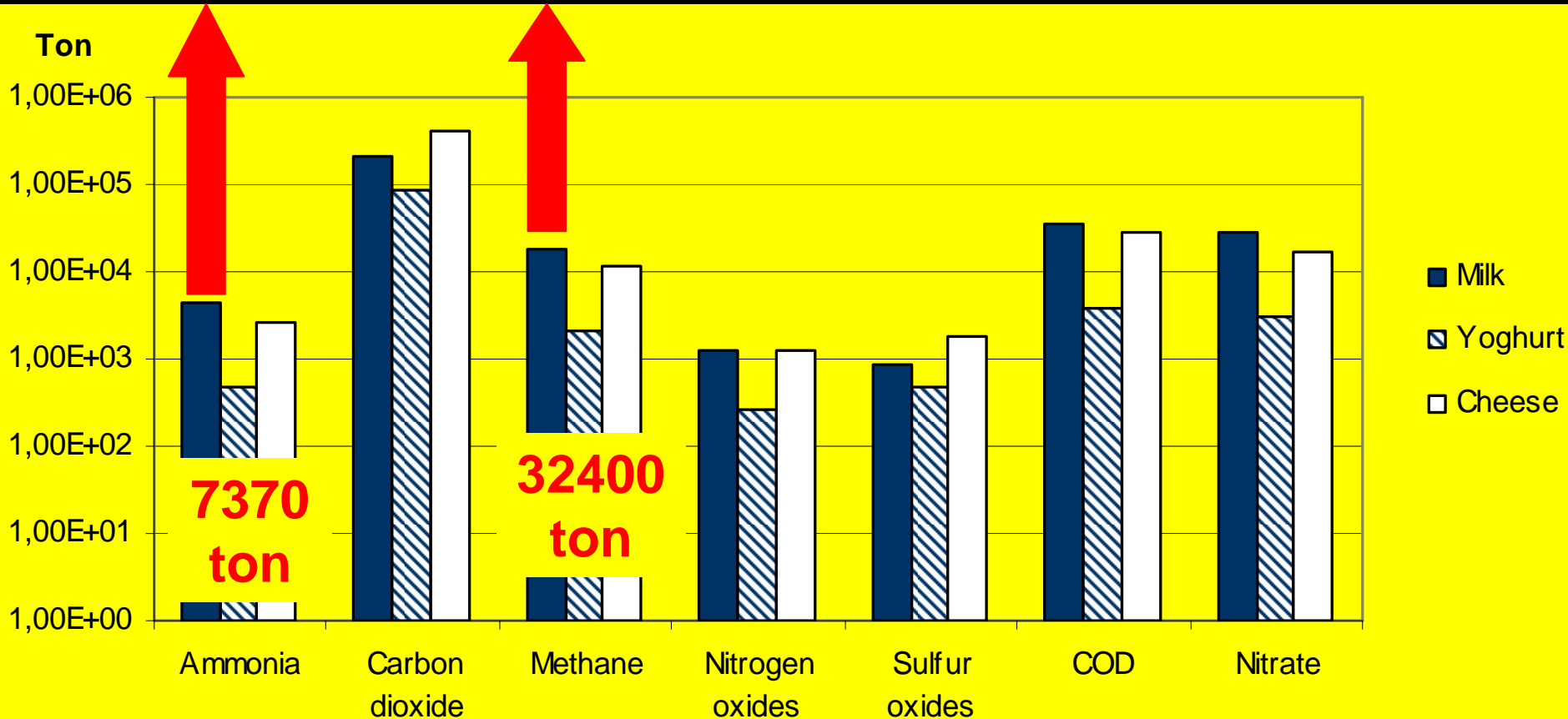
Impact assessment

<i>Impact category</i>	<i>Parameters</i>	<i>Characterization factor (Source)</i>
<i>Global Warming (GW100)</i>	$\text{CH}_4, \text{CO}_2, \text{N}_2\text{O}$	Houghton J. T <i>et al.</i> , 2001
<i>Photochemical oxidation (PO)</i>	CH_4, SO_x (included SO_2)	Jenkin & Hayman, 1999; Derwent <i>et al.</i> , 1998
<i>Acidification (A)</i>	$\text{NH}_3, \text{SO}_x, \text{NO}_x$	Huijbregts, 1999
<i>Eutrophication (E)</i>	$\text{NO}_3^-, \text{NH}_3, \text{CQO},$ $\text{NO}_x, \text{PO}_4^{3-}$	Heijungs <i>et al.</i> , 1992

Results

Inventory analysis results

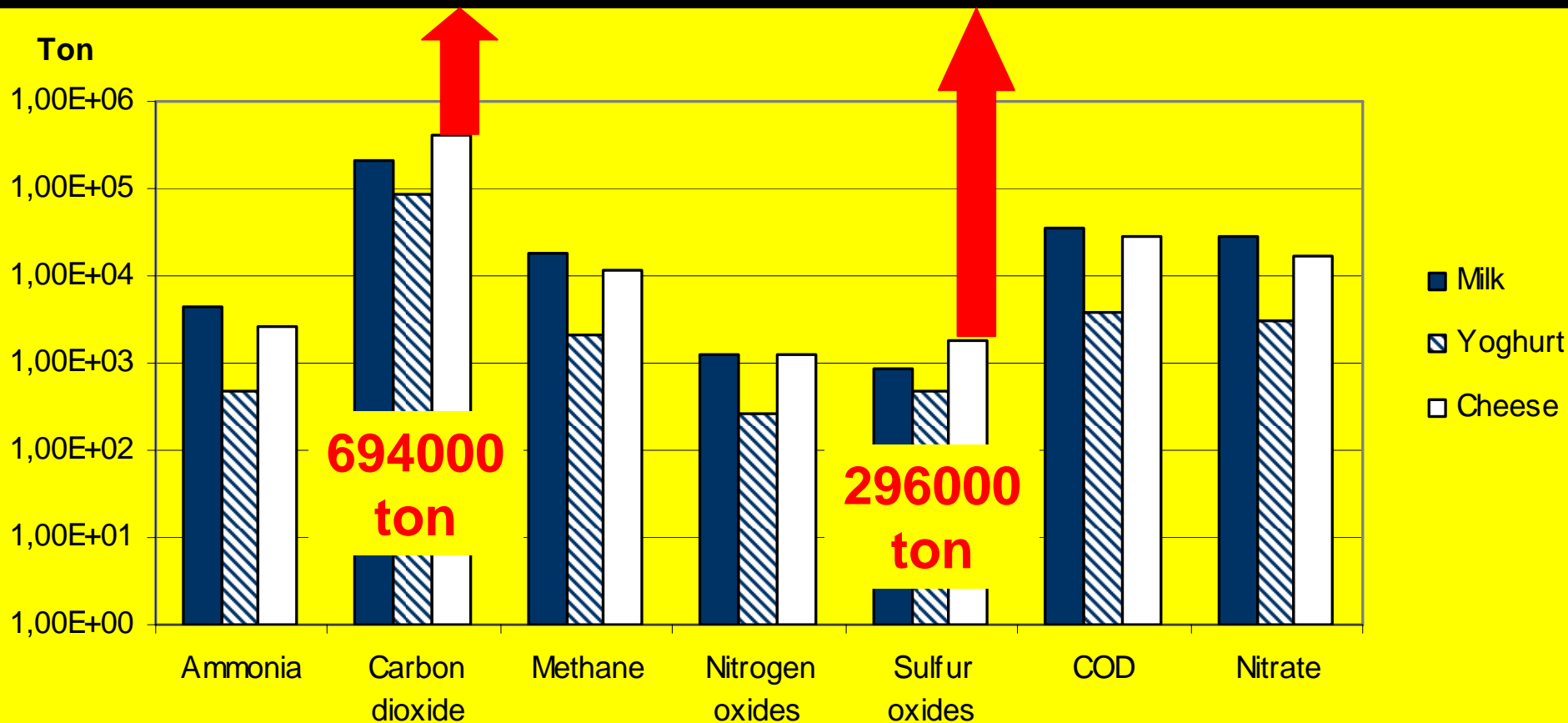
**About 60% are related with milk for consumption
(especially in the phase of raw milk production at farms)**



Results

Inventory analysis results

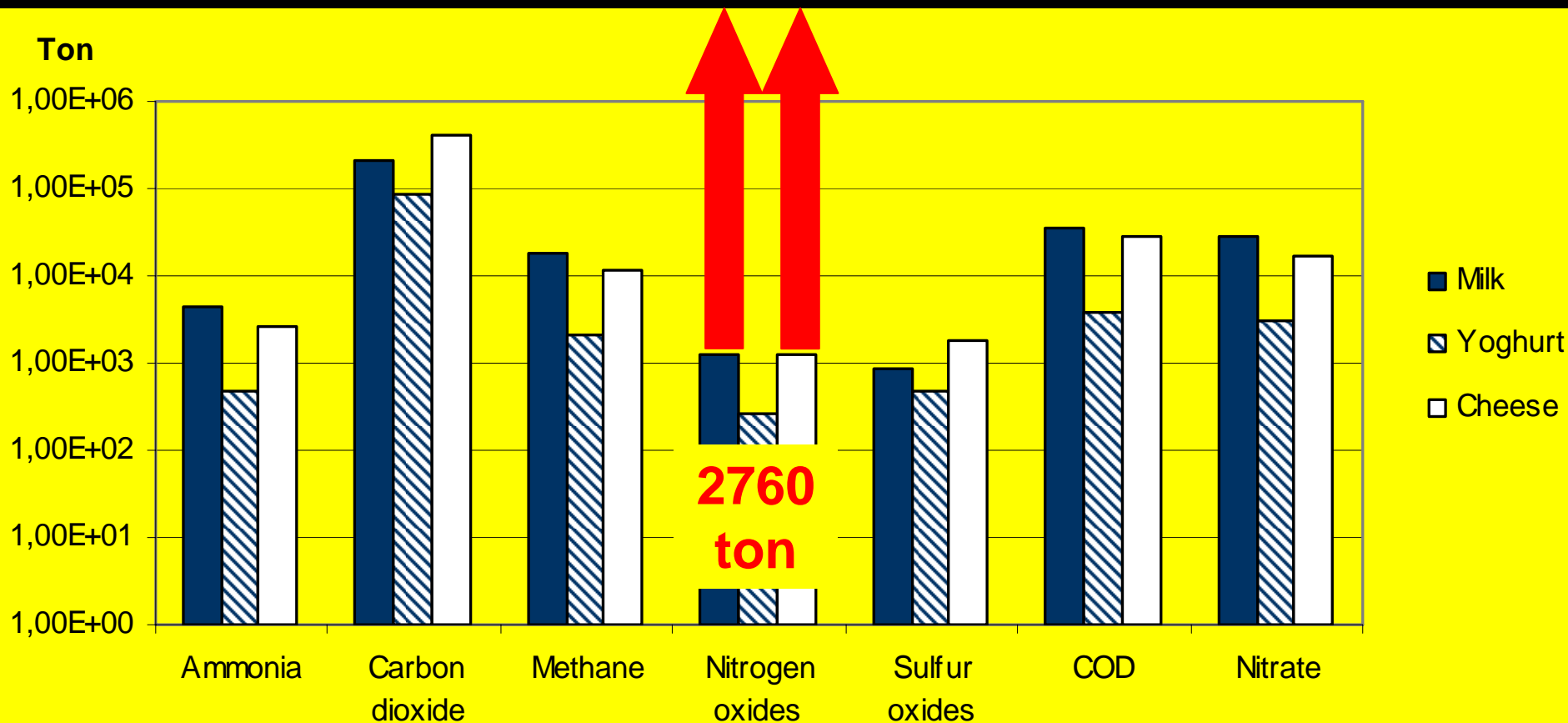
This is due to the higher consumption of different forms of energy during the processing of curd cheese



Results

Inventory analysis results

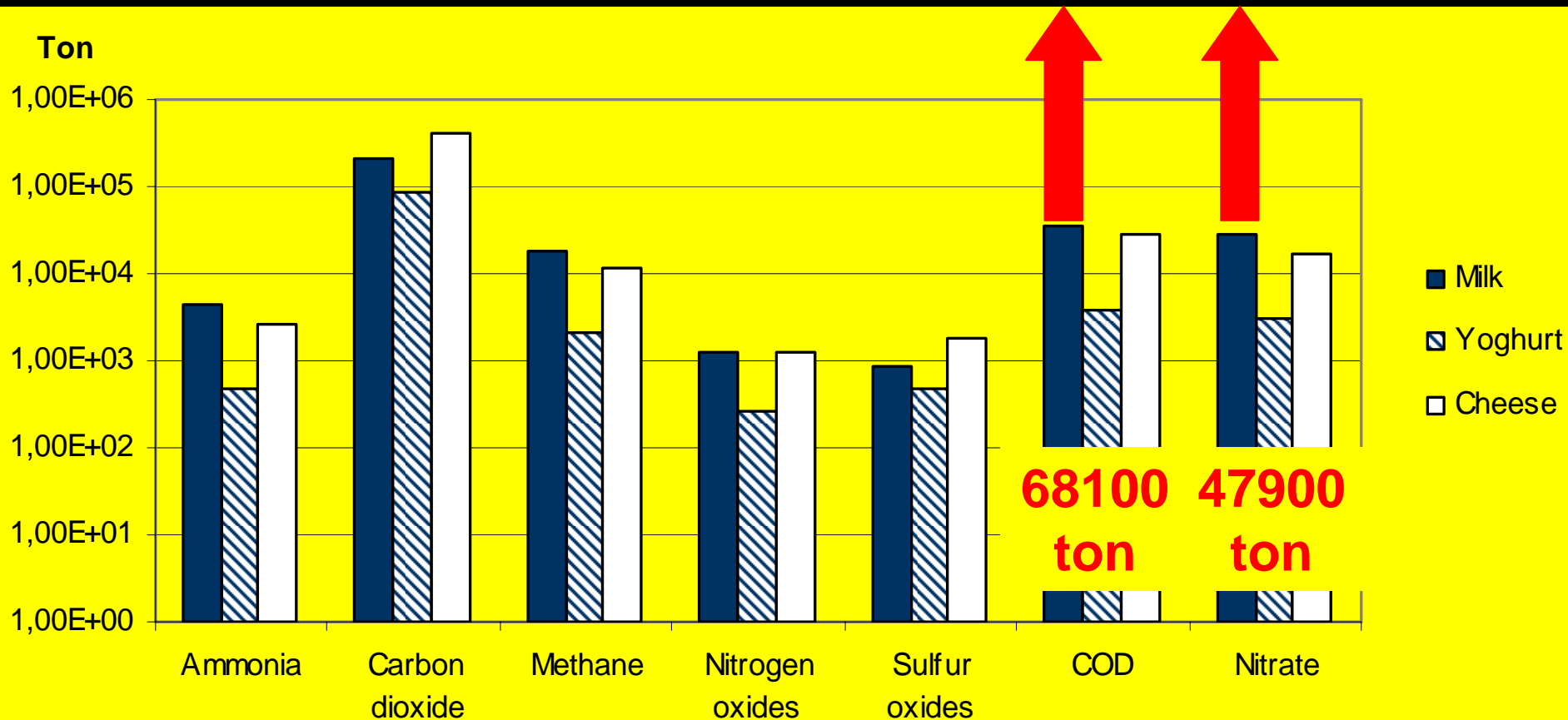
The production of milk and curd cheese have similar contributions to the global NO_x emission



Results

Inventory analysis results

Although the processing of milk is associated to a lesser wastewater production in comparison with the processing of curd cheese, the amount of raw milk going to the production is significantly higher



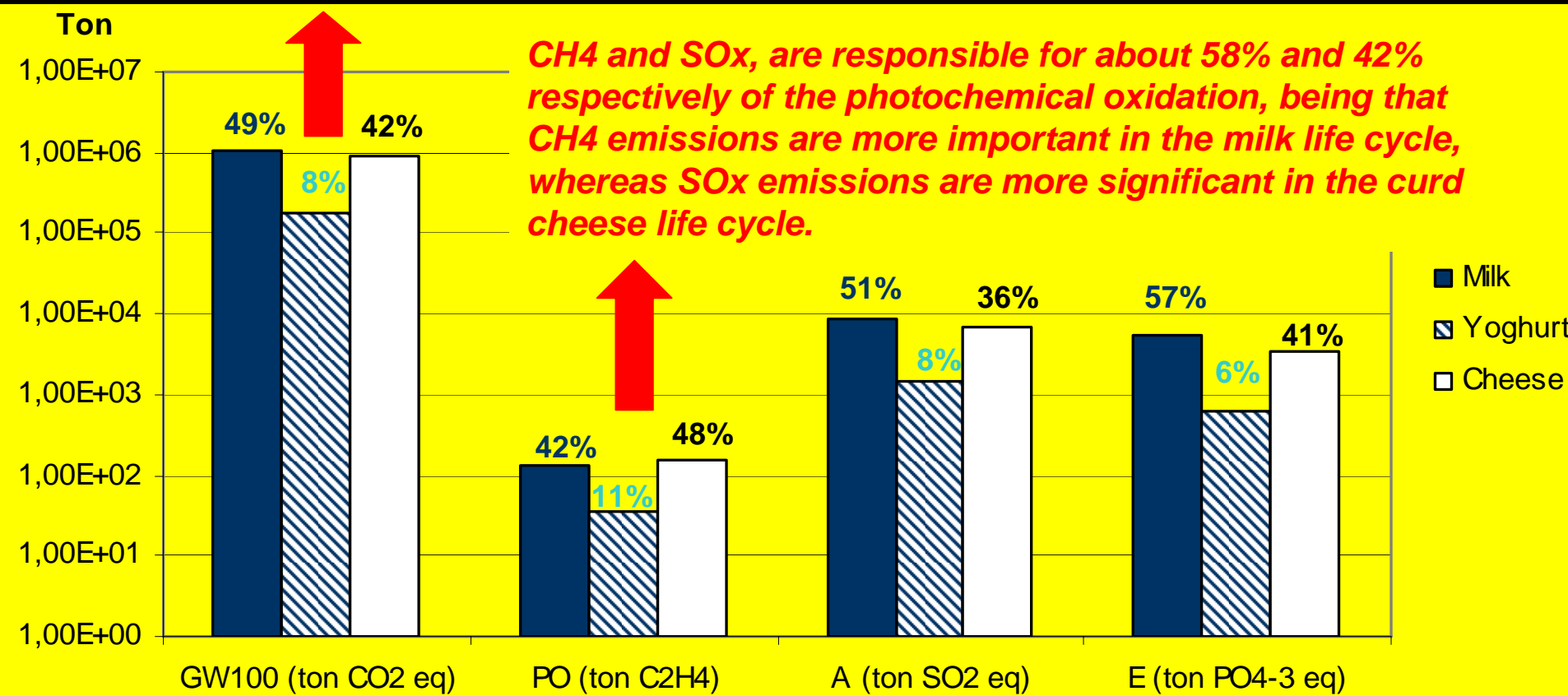
Results

Impact assessment results

CH₄, CO₂ and N₂O have similar contributions

N₂O and CH₄ emissions are more significant for the production of consumption milk

CO₂ emissions are higher for the production of curd cheese

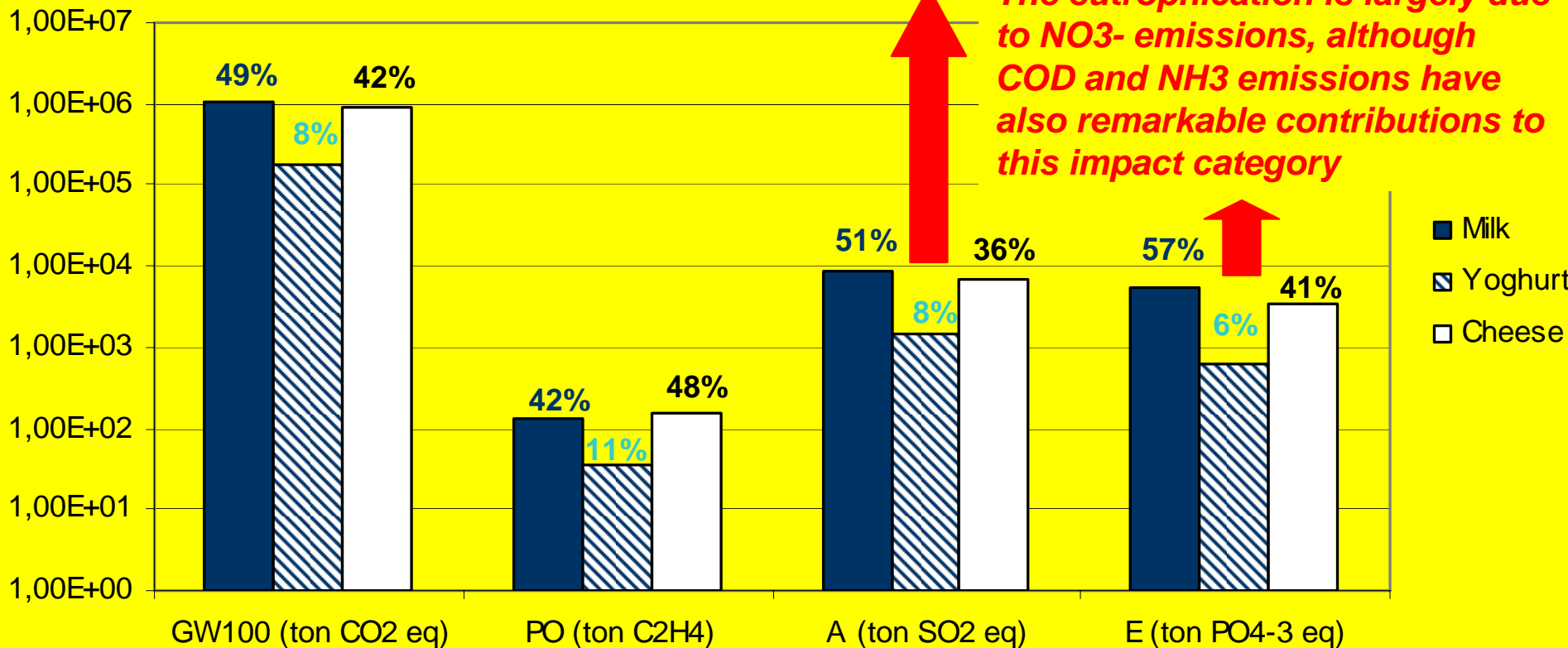


Results

Impact assessment results

NH3 emissions contribute almost in 70% for the acidification impact category, followed by the emissions of SOx (21%). Emissions of NH3 are higher in the milk production, whereas the emissions of SOx are more significant in the curd cheese production

The eutrophication is largely due to NO3- emissions, although COD and NH3 emissions have also remarkable contributions to this impact category



Conclusions

- Milk for consumption and curd cheese production had the largest contributions for the inventory parameters and impact categories analysed.



these are the processes to which mitigation measures should be proposed

- This study identified information gaps regarding inventory data in all the stages of the life cycle of dairy products in Portugal



this is an area for further improvement



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