Life Cycle Assessment of Italian High Quality Milk Production

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Aims of this presentation

- To present the **LCA case study** of an Italian brand of **high quality milk**;
- To highlight the main **critical issues** concerning the **comparability** of the results of different LCA studies on the same product.

Goals of the LCA study

- **To assess** the environmental impacts coming from the **life cycle of an Italian brand of high quality milk** and to identify the **most critical hotspots**;
- **To compare** these LCA results with the **registered EPD® of milk**.

This case study was performed in compliance with the PCR for milk and milk based liquid products (version 2006).

High quality milk and functional unit

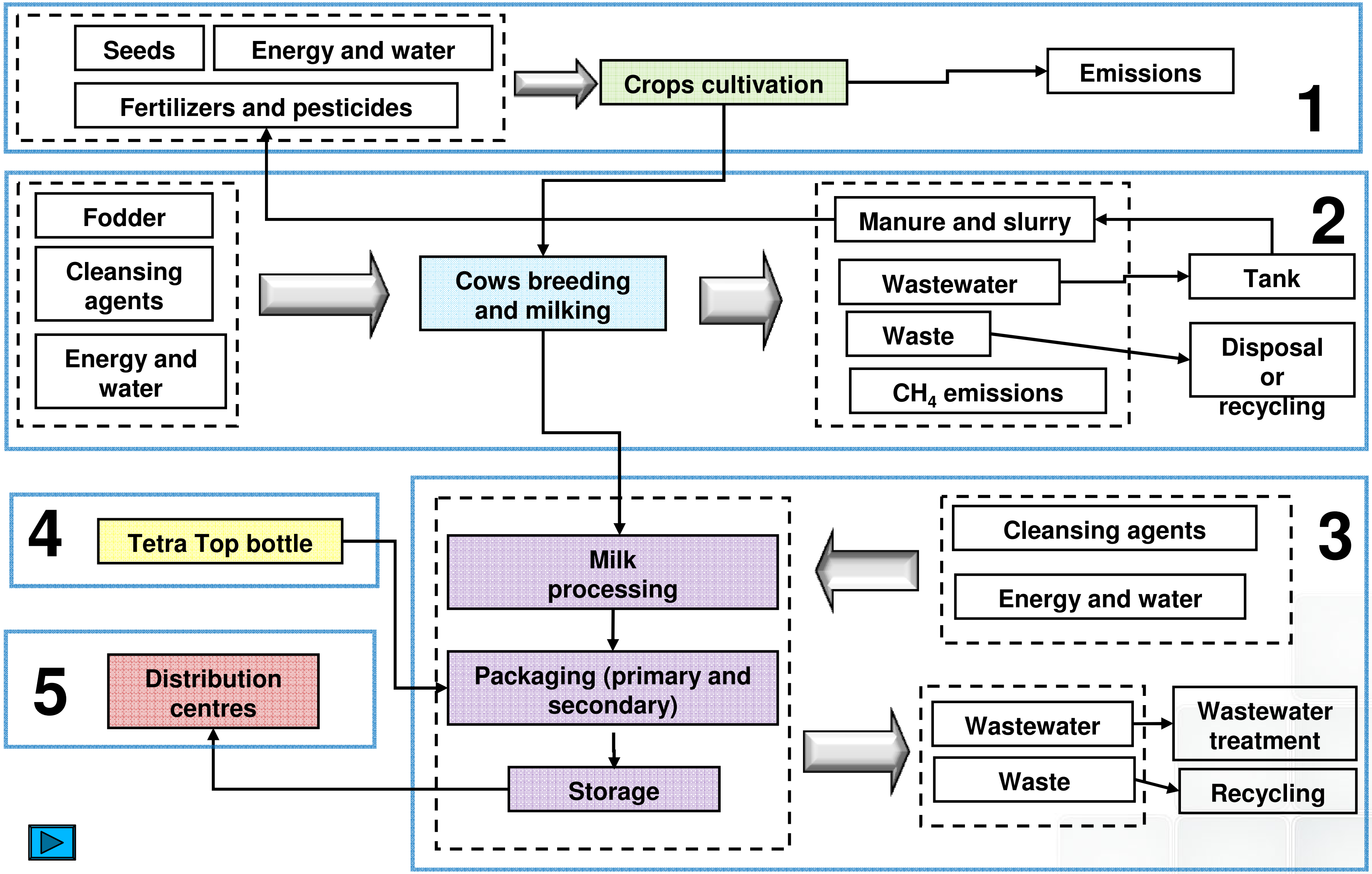
High quality milk

- Fat content of raw milk > 3,6%;
- Proteins content of raw milk > 32 g/l;
- Compliance with rigorous requirements fixed by the Italian regulation.

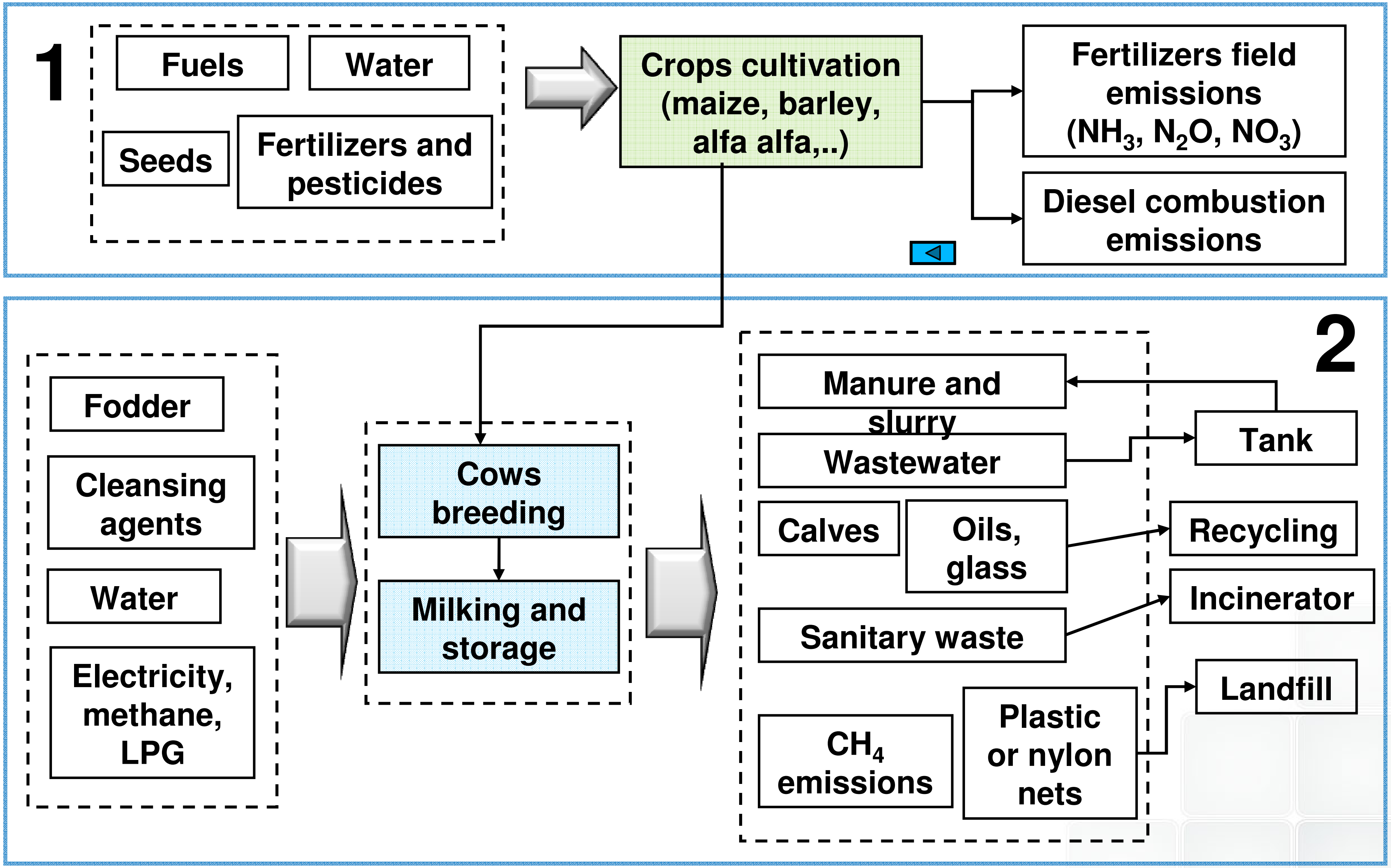
Functional unit ⇒ **1 litre of high quality milk bottled in a Tetra Top package**

- Cardboard
- Polyethylene

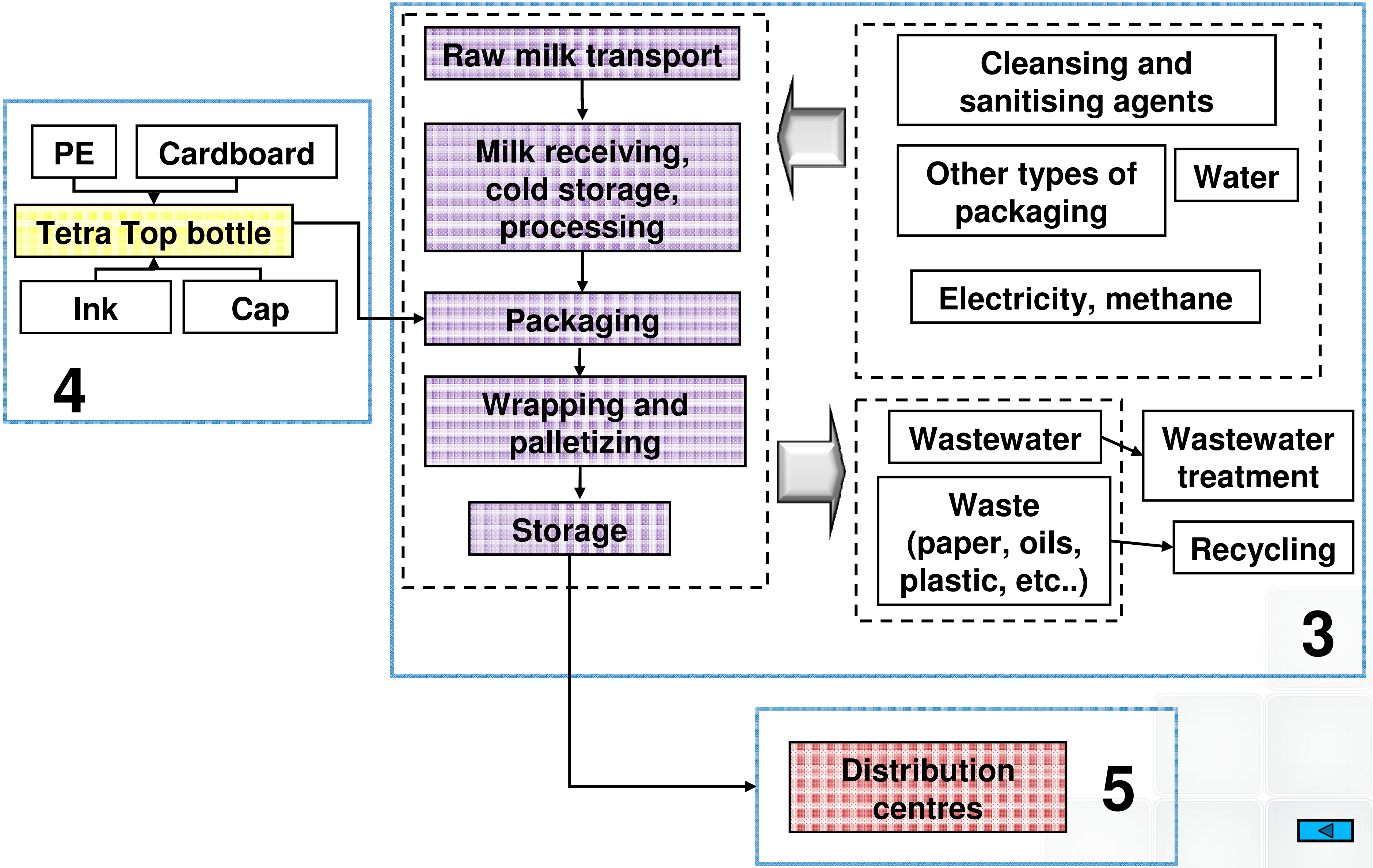
System Boundaries



System Boundaries-1

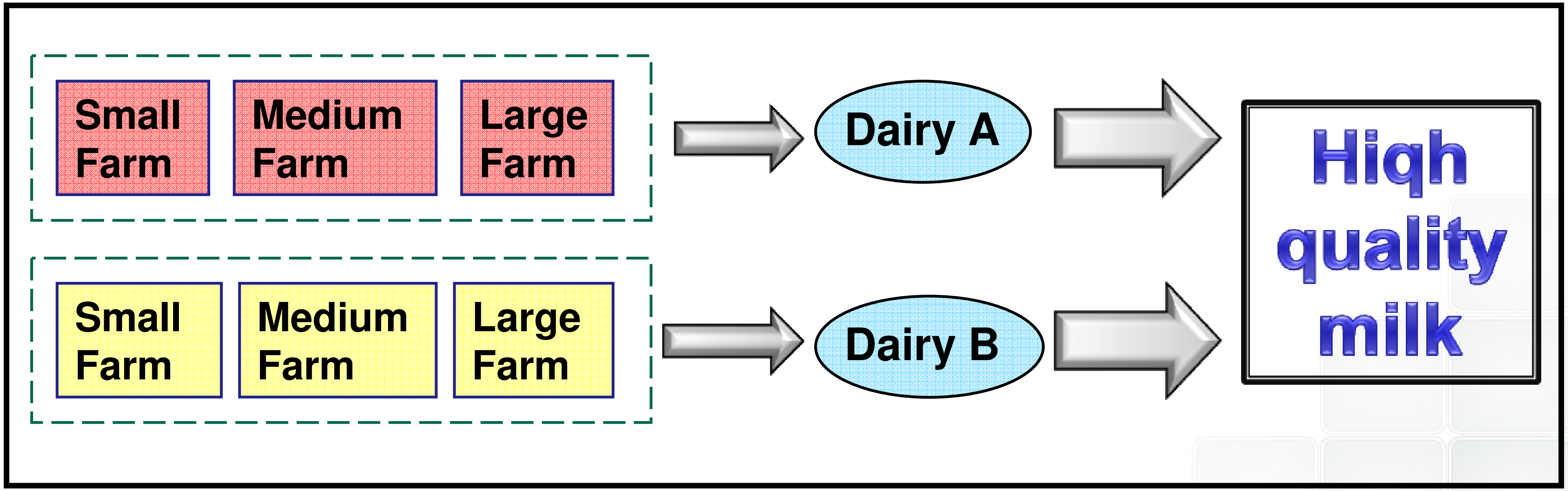


System Boundaries-2



Data collection

- ✓ **5** farms are suppliers of **dairy A**, whereas **13** farms are suppliers of **dairy B**;
- ✓ Milk suppliers of **dairy B** are located in a mountain region and have a yearly average production lower than suppliers of **dairy A;**
- ✓ A **representative sample** was created by dividing farms in **classes**;
- ✓ The size of each class was defined according to the **milk daily production**.



Inventory and data quality

Primary data	
Farms (2007)	**Dairies A and B (2008)**
Crops cultivation (energy, water, fertilisers and pesticides consumption) for fodder production	Transports from farms and to distribution centres
Number of cows in the farm, their daily fodder intake and milk yearly production for each farm	Energy, water and cleansing agents consumption
Water, fuels, electricity and cleansing agents consumption at cowsheds	Primary and secondary packaging consumption
Waste production (plastic, paper, slurry, manure)	Waste production (plastic, paper, exhausted oils)

- ✓ Data of **Tetra Top bottle production** from an LCA study of Tetra Pak.
- ✓ Databases (**Ecoinvent, LCA Food, ETH**) and literature were used for all background data.

Impact Assessment results-1

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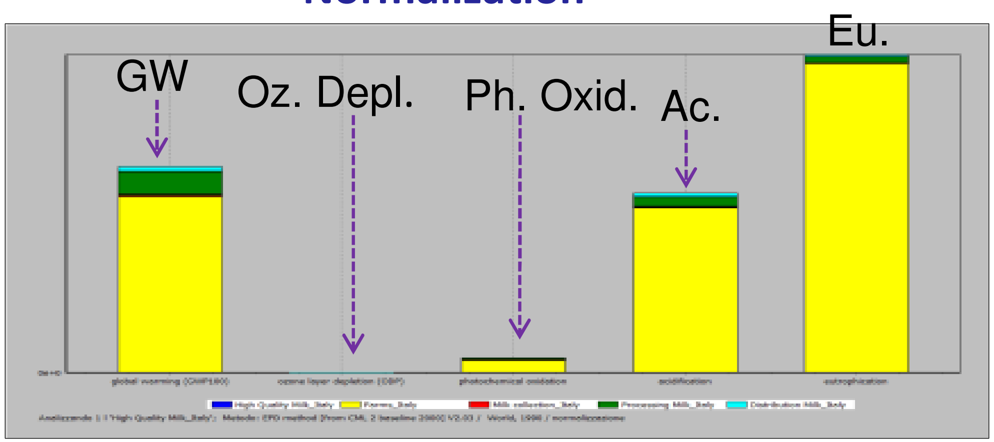
Impact categories	Units	Total	Farm operation	Milk delivery	Milk processing at dairies	Transport to distribution centres
Global warming	kg CO_2 eq.	1,54	**84%**	1%	12%	3%
Ozone layer depletion	kg CFC-11 eq.	7E-08	**61%**	3%	26%	10%
Photochemical oxidation	kg C_2H_4 eq.	2,8E-04	**83%**	1%	12%	4%
Acidification	kg SO_2 eq.	1E-02	**90%**	1%	7%	2%
Eutrophication	kg PO_4^{3-} eq.	7,8E-03	**97%**	<1%	2%	<1%

Normalization



The contribution to ozone depletion and photochemical oxidation is **negligible**

Impact Assessment results-2

Impact categories	Main emissions	Processes
Global warming	CH_4 (36%)	Enteric fermentation
	CO_2 (37%)	Diesel consumption during agricultural field work processes
	N_2O (27%)	• Chemical and organic fertilizers use • Cultivation of soy contained in complementary fodder
Acidification	NH_3 (71%)	Organic fertilizers use
	NO_x (17%)	Diesel consumption during agricultural field work processes
Eutrophication	NO_3 (65%)	• Chemical and organic fertilizers use • Soy and maize cultivation for the production of complementary fodder
	NH_3 (21%)	

Comparison with literature studies-1

At farm gate (per kg FPCM)			
GWP ($kg\ CO_2eq$)	Acidification ($kg\ SO_2\ eq$)	Eutrophication ($kg\ PO_4^{3-}\ eq$)	Country[b]
1,08	1,8E-2	6,1E-3	Sweden/C
0,95	1,6E-2	6,8E-3	Sweden/O
1,4	9,5E-3	1,1E-2	Netherlands/C
1,5	1E-2	7E-3	Netherlands/O
0,84[a]	**5E-3 [a]**	**3,9E-3 [a]**	**Spain/C**
1,3-1,5	-	-	Ireland/C
0,86	7,4E-3	2,7E-3	New Zealand/C
1,0	**-**	**-**	**U.S./O**
1,03	**8,2E-3**	**9,3E-3**	**France/C**
1,32	**9,2E-3**	**7,7E-3**	**Italy/C**

Whole milk life cycle (per kg FPCM)			
GWP ($kg\ CO_2\ eq$)	Acidification ($kg\ SO_2\ eq$)	Eutrophication ($kg\ PO_4^{3-}\ eq$)	Country[b]
1,05[a]	**8,5E-3[a]**	**5,3E-3[a]**	**Spain/C**
1,7[a]	**-**	**-**	**U.S./O**
1,17	**8,9E-3**	**9,8E-3**	**France/C**
1,57	**1,02E-2**	**7,9E-3**	**Italy/C**

[a] These results are given per litre of milk; [b]C= conventional; O= Organic

Results per litre of milk

Results per kg FPCM (Fat and Protein Corrected Milk)

- ✓ Impacts of raw milk production;
- ✓ Values of CH_4 emissions during enteric fermentation;
- ✓ Dispersion models for calculation of fertilizers field emissions.

Comparison with literature studies-2

The results of our study **fall within the range of the literature studies values**, but a more detailed comparison is not possible because of the **different methodologies and assumptions** used in each of these LCAs.

Difficulty of comparing different LCA studies on the **same product**: results are affected by methodological choices adopted by LCA practitioners in the modelling. No conclusion can be drawn from them on the environmental preferable milk.

Comparison with the registered EPD on milk-1

PCR defines a **framework** that allows different EPDs of the same product cathegory to be **compared.**

This study → **M1**

EPD of milk → **M2**

- ✓ The same system boundaries;
- ✓ Milk was produced in the same geographical area;
- ✓ Milk was processed following similar technologies;
- ✓ Both LCA studies were carried out in compliance with the PCR for milk.

BUT

The results of these studies are not fully comparable!!

Comparison with the registered EPD on milk-2

Impact category	[(M1-M2/M2)*100]	Interpretation
Global warming	+18%	Inclusion of N_2O airborne emissions in study M1
Acidification	+82%	Inclusion of NH_3 airborne emissions from fertilizers use in study M1
Eutrophication	+76%	Models used for NO_3 waterborne emissions calculation and inclusion of NH_3 airborne emissions from fertilizers use in study M1
Resources with energy content	>100%	Inclusion of the biomass (soy, corn, barley) energy content in study M1
Resources without energy content	>>100%	Inclusion of sodium chloride and calcium carbonate flows (contained in complementary fodder) and of gravel flow in study M1
Waste production	-88%	Inclusion of waste disposal in study M1

Previous PCR for milk lacked detailed rules on these important topics:

- ✓ Inclusion of fertilizers field emissions and the dispersion models to be adopted;
- ✓ Inclusion of flows related to complementary fodder;
- ✓ Waste disposal.

Different hypotheses adopted during the modelling phase led to very different results.

Conclusions

- **Raw milk production at farms** dominates the whole life cycle of high quality milk for all impact categories (its percentage contribution is always higher than 60%);
- Main emissions affecting the results are: **CH_4** from enteric fermentation, **CO_2** from diesel consumption and **NH_3 airborne emissions** as well as **NO_3 waterborne emissions** coming from chemical and organic fertilizers use;
- **Results comparability** of different LCA studies on similar products is a **critical issue**: the results are affected by specific assumptions and modelling adopted by LCA practitioners→**Harmonisation efforts** are necessary;
- **EPD® comparability** cannot be assured when PCR document lacks detailed rules on some important topics. The revised version of the PCR for milk (published June 2010) considers this issue and defines improved rules and prescriptions.

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Thank you for your attention