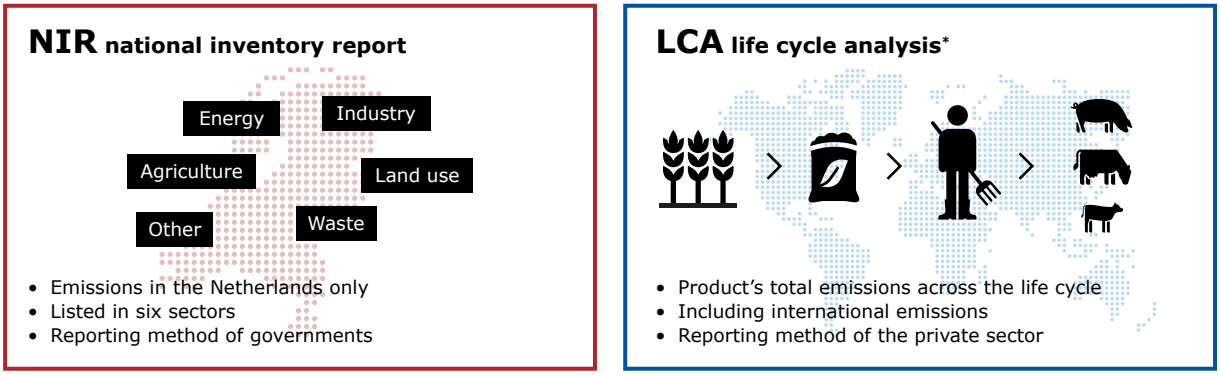
Monitoring greenhouse gas emissions of livestock production

Understanding the effect of different approaches

Introduction

Greenhouse gas emissions of livestock production can be reported using either a national inventory report (NIR) or a life cycle analysis (LCA) (Figure 1). Government reporting is based on a NIR approach, while the private sector uses an LCA approach. The NIR approach reports greenhouse gas emissions of specific sectors within a country, while the LCA approach reports greenhouse gas emissions of the entire supply chain (regardless of the country) for a particular product.

Both approaches are based on internationally developed standards and protocols. They each have their own background and applications but they can show different mitigation options.



* A life cycle analysis can define a supply chain according to different system boundaries. The main aim here is to compare the impact of livestock production and therefore only emissions until farm gate are included. Emissions that occur downstream (processing, transport, retail, consumers) have been excluded.

Figure 1 Brief description of the differences between the national approach (NIR) and life cycle approach (LCA).

The objectives for reduction of greenhouse gas emissions in agriculture in the Dutch National Climate Agreement are based on the NIR-sector Agriculture (one of the six NIR sectors (Table 1)). The livestock sector can, however, also contribute to the reduction of greenhouse gas emissions in other NIR sectors and countries, through modifications to feed production and composition, for example, or through the production of sustainable energy.

Such modifications show reductions in the LCA approach, but they wouldn't be visible in the Dutch NIR-sector Agriculture. One of the objectives of the Climate Perspective PPP is to combine both methods to show how greenhouse gas emissions from Dutch livestock production are reported according to both approaches, and how they relate.

Table 1 Overview of agriculture-related emissions included in the various NIR sectors

NIR sector	Agriculture-related emissions included
Energy	Emissions related to energy consumption, for example electricity generation and transportation.
Industrial processes and product use	All non-energy related emissions caused by industrial activities and product use, such as calcium, ammonia and nitric acid production.
Agriculture	Emissions from animals (e.g. enteric fermentation), livestock barns and manure storage, and from the application of fertilisers.
Land use, land use change and forestry	Emissions and sequestration through land use, changes in land use and forestry.
Waste	Emissions caused by digestion and incineration of manure.
Other	No greenhouse gas emissions are reported here for the agricultural sector.

Results

Figure 2 shows total emissions associated with the production of one kg of product in three sectors (dairy cattle, pigs, veal calves) by using the LCA approach. These emissions are then allocated to the sectors and regions (Netherlands, Europe, Rest of the World) in which they would be reporting under the NIR approach. This shows how greenhouse gas emissions across the entire production chain are divided over particular regions and NIR sectors. Such an approach allows us to create a more comprehensive picture of opportunities for the livestock sector to reduce their climate impact.

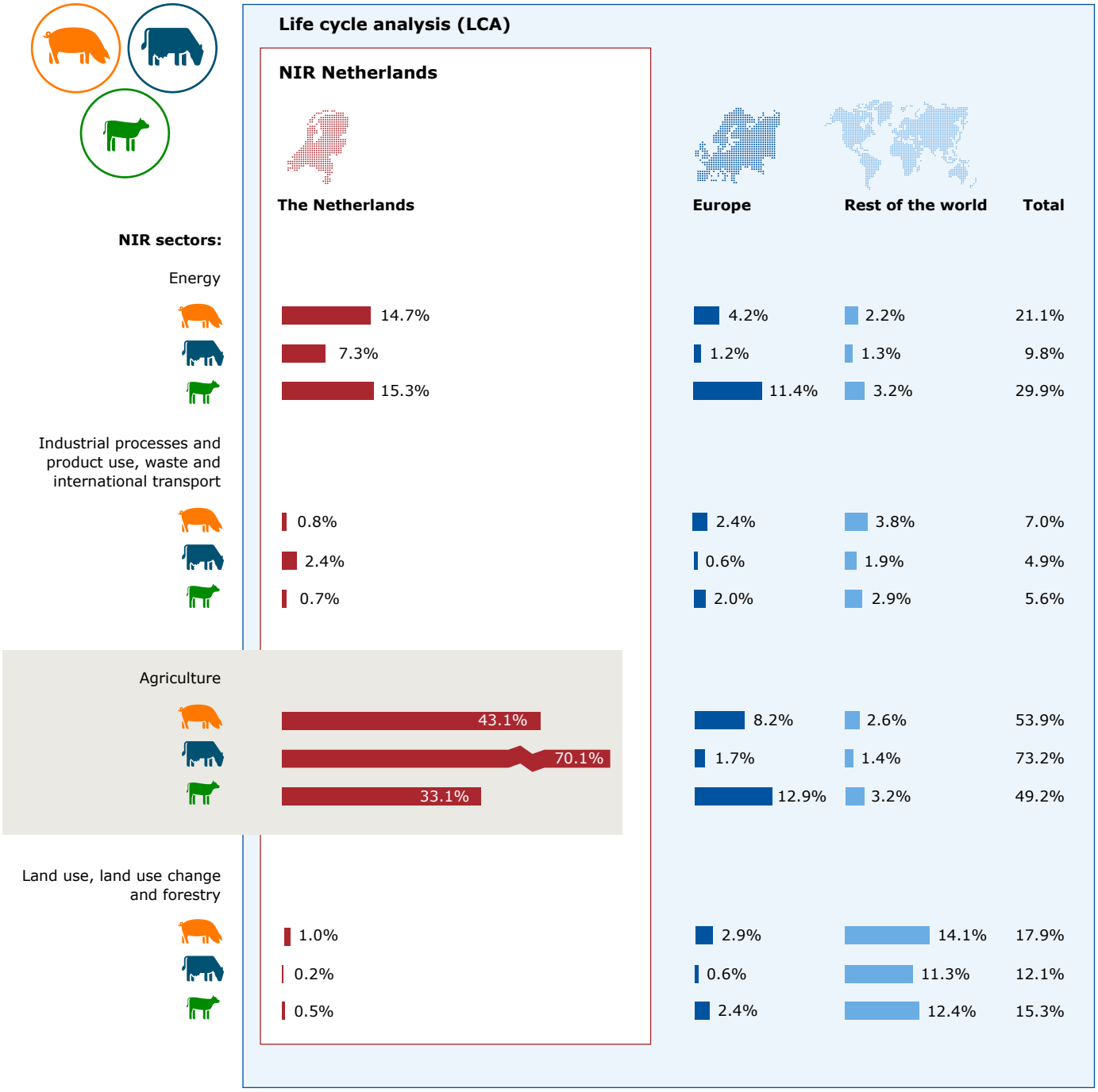


Figure 2 Greenhouse gas emissions (CO_2 equivalents per kg of product supplied according to life cycle analysis from cradle to farm gate) broken down (%) by NIR sector and region in which emissions occur [1]

1 More information on how various processes contribute to emissions is available in the sector-specific factsheets

Conclusions

1 For livestock production, a important part of the total emissions occur outside the Dutch NIR-sector Agriculture. For the three sectors under consideration this amounts to 57% (pigs), 30% (dairy cattle) and 67% (veal calves).
2 Some of the emissions occur abroad. For the three sectors under consideration this amounts to 40% (pigs), 20% (dairy cattle) and 50% (veal calves).
3 The most important emissions sources outside the Dutch NIR-sector Agriculture are:
   a. Emissions associated with the production of feed ingredients. A large proportion of this is located in the NIR-sector Land use – rest of the world. These are emissions resulting from deforestation for the production of compound feed ingredients.
   b. Emissions associated with the production and use of energy (NIR-sector Energy in the Netherlands and abroad). This relates to energy consumption on farms but also further upstream during the processing of feed ingredients.

Implications

1 If the policy focus is restricted to the Dutch NIR-sector Agriculture a large proportion of the emissions in the supply chain is not their scope. The reductions that the livestock sector can achieve in other NIR sectors and regions aren't visible, so government policy doesn't recognise or incentivise such reductions.
2 A single policy focus on the Dutch NIR-sector Agriculture for the Dutch livestock sector may result in displacing emissions to other NIR sectors and regions.
3 The use of a matrix approach allows to show effects in other NIR sectors and regions while effects in the Dutch NIR-sector Agriculture remain visible.
4 The matrix approach could be used by governments and the private sector to maintain a broader perspective on greenhouse gas emissions when identifying mitigation options and monitoring progress.

Methods

- Greenhouse gas emissions have been calculated using the LCA methodology.
- Emissions are divided by region (the Netherlands, Europe, Rest of the World), NIR sector (see Table 1) and international transport (falling outside of the NIR sectors).
- This spread is shown in Figure 2.
- Note: The two methods use different Global Warming Potentials for converting methane and nitrous oxide to CO_2 equivalents (CO_2 eq).

LCA calculation
Existing LCA methodologies have been used as much as possible (ISO, LEAP, PEFCR). Emissions are summed and expressed as CO_2 eq where 1 kg CH_4 is 34 kg CO_2 eq and 1 kg N_2O is 298 kg CO_2 eq. Allocations are made according to the PEFcr, with manure being a residual product of no value.

System limits
Emissions have been calculated from 'cradle to farm gate'. This means they include all emissions, including upstream, until the product leaves from the farm. Emissions from manure processing, peat oxidation associated with the production of roughage, and carbon sequestration in soils, were excluded because the methodologies for these are still being developed and are being used only on a limited scale.

For pigs (fattening pig) and calves (white veal) emissions are expressed per animal supplied, and for dairy cattle per kilogram of fat-and-protein-corrected milk.

Data sources

- Farm data (such as feed use, energy consumption, number of livestock): Farm Information Net (BIN) at Wageningen Economic Research, NIR.
- Feed composition: Schothorst Feed Research, Circular Feed Association.
- Nutrient composition of feed based on Schothorst Feed Research, BIN, and report of the Annual Nutrient Cycling Assessment (KringloopWijzer).
- Background data: Agri-footprint 6 (Blonk Consultants).
- Excretion of organic matter and nitrogen have been calculated.
- Enteric methane emission factor of compound feed based on the report KLW, calculated for roughage.

Life cycle analysis (LCA)

NIR Netherlands

NIR sectors:	**The Netherlands**	**Europe**	**Rest of the world**	**Total**
Energy	14.7%	4.2%	2.2%	21.1%
Industrial processes and product use	0.8%	2.4%	2.3%	5.4%
Agriculture	43.1%	8.2%	2.6%	53.9%
Land use, land use change and forestry	1.0%	2.9%	14.1%	17.9%
waste	0.04%	0.02%	0.5%	0.6%
NIR subtotal	**59.6%**	**17.7%**	**21.7%**	**99%**
International transport				1.0%
Total				**100%**

Life cycle analysis (LCA)

NIR Netherlands

NIR sectors:	The Netherlands	Europe	Rest of the world	Total
Energy	7.3%	1.2%	1.3%	9.8%
Industrial processes and product use	2.4%	0.6%	1.0%	4.0%
Agriculture	70.1%	1.7%	1.4%	73.2%
Land use, land use change and forestry	0.2%	0.6%	11.3%	12.1%
Waste	0.04%	0.01%	0.3%	0.3%
NIR subtotal	**80%**	**4.1%**	**15.3%**	**99.4%**
International transport				0.6%
Total				**100%**

Life cycle analysis (LCA)

NIR Netherlands

NIR sectors:	The Netherlands	Europe	Rest of the world	Total
Energy	15.3%	11.4%	3.2%	29.9%
Industrial processes and product use	0.7%	2.0%	1.6%	4.3%
Agriculture	33.1%	12.9%	3.2%	49.2%
Land use, land use change and forestry	0.5%	2.4%	12.4%	15.3%
Waste	0.01%	0.02%	0.4%	0.4%
NIR subtotal	**49.6%**	**28.7%**	**20.8%**	**99.1%**
International transport				0.9%
Total				**100%**

Acknowledgements

This factsheet is a result of the public-private partnership project *'Climate Perspective Dutch agro-production'* for Top Sector Agri & Food (TKI LWV19183).
More information on the Climate Perspective PPP is available online at Wageningen University & Research, Climate Perspective on Dutch agro-production

Contact
Pim Mostert
E pim.mostert@wur.nl

Authors: Pim Mostert, Joan Reijs (Wageningen University & Research) and Nynke Draijer (Blonk Consultants)