

Lely Sphere

Laymans Report

LIFE-CMCD



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EU contribution: €1,846,434



*Closing the mineral cycle
in European dairy farming*



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Introduction

Circular economy

The world population will increase over the coming decades, but the amount of land, water and other means of production available to humanity is limited. The agricultural sector is facing the challenge of scaling up food production while ensuring that it is sustainable at the same time. We must move towards a circular economy for the future of our planet. This means the responsible use of our natural resources and the reuse of waste streams as new raw materials. Dairy farmers must therefore close the mineral cycle on their farms as much as possible and limit the loss of valuable nutrients via manure.

Animal manure has always been a valuable raw material for farmers to keep soil fertile and provide nutrients for crops. Modern dairy farming has tended to ignore this function and the role of manure has partly been taken over by chemical fertilisers.

Most dairy farms fertilise their fields with slurry, thin animal manure that is stored in manure pits or basins, but this is not ideal. In the first place, it is difficult to match nutrients specifically with the needs of soil and crops. Secondly, slurry systems cause problematic emissions, both in the barn and manure storage, and during fertilising on land.

Lely wants to rely on a more circular approach, to limit the loss of nutrients via emissions and enable dairy farmers to use the nutrients in manure optimally.

Ammonia

This project is specifically focussed on limiting the emissions of ammonia (NH_3) by dairy farms and on reusing the nitrogen in ammonia as a crop fertiliser. Ammonia is a colourless gas with a strong odour. It is created when plant material decomposes and during conversion processes in manure. This gas is a problem, because when it ends up in the atmosphere it aggravates air pollution. This effect is both direct and indirect, because ammonia stimulates the formation of particulate matter (PM). Ammonia deposition also causes two other environmental problems: acidification and eutrophication. Both of these damage sensitive vegetation, biodiversity and water quality.

In the amended Gothenburg Protocol on the global reduction of emissions of air pollutants, EU Member States committed themselves to reducing emissions of ammonia and particulate matter.

The project under discussion here is aimed at a solution for dairy farming. The share of ammonia emissions in the EU caused by this sector is relatively large.





Objectives and intended results

Lower emissions and reuse of ammonia

The objective of this project is to develop a system (Lely Sphere) that will allow dairy farmers to limit the emissions of ammonia from their farms significantly and to use the captured ammonia as fertiliser.

A 70% reduction in emissions from the barn is expected.

Reuse of minerals for sustainable crop cultivation

The reduction in emissions achieved by the system limits the negative impact on the environment. Lely Sphere also helps make farming operations more circular. Lely Sphere converts ammonia from manure into another nitrogen compound, namely ammonium, which can be used as fertiliser. This gives farmers access to a separate stream of nitrogen nutrients that he/she can use alongside animal manure. This animal manure contains less nitrogen, but is still rich in other nutrients and organic substances. By alternating these two streams of nutrients according to the needs of the soil, farmers can give their crops what they require and improve the quality of the soil. In addition, farmers do not need to buy so much chemical fertiliser.

Safer and healthier for people and animals

Another advantage of this system is that it also limits other emissions, such as particulate matter and manure gases. Manure gases are generated by decomposition processes in the manure pit and can rise into the barn via the slatted floor. These gases damage the health of both people and animals, besides which methane is highly flammable.

Lely Sphere's modified slatted floor and ventilation system prevent manure gases from entering the barn, so the system improves the climate in the barn. The space where the cows live and the working environment of the farmer and his/her employees become safer, healthier and more pleasant. The air in the barn is extracted via the manure pit, so the natural ventilation in the barn is maintained. The system is therefore also suitable for farmers with cows that graze outside.

Partners

This LIFE project is being carried out by Lely Technologies NV, Lely International NV, Lely Industries NV, and Lely Holding BV.

Description of the system and the innovations

A combination of technologies

The results achieved with the Lely Sphere system are due to two effects. The first effect is to limit the formation of ammonia in the barn with technology designed for this purpose. The second effect is to remove ammonia from manure by means of a unit that extracts air from the manure pit and the barn and captures the ammonia contained in it.

Lely Sphere is a combination of various technologies: a modified barn floor, a manure robot, a unit that extracts air from the manure pit and the barn and converts the ammonia it contains into circular fertiliser, and a silo to store the circular fertiliser. These four elements complement each other.

The surface of the modified floor is perforated to separate manure from urine. Urine passes through

the perforations, while the manure remains on the floor, where it is collected by the manure robot. Manure and urine barely come into contact with each other on the floor. This is the first step in reducing ammonia emissions, as ammonia is created when manure and urine are mixed. An enzyme in the manure promotes a chemical reaction that changes a nitrogen compound in the urine (urea) into ammonia.

Ammonia can form under the floor in the manure pit, but it is extracted by the N-Capture, the third element of the system. The N-Capture sucks the air from the pit and blows it through a filtering system. The ammonia from the extracted air is captured and converted into another nitrogen compound (ammonium), which can be used as a substitute for chemical fertiliser.

A more detailed description follows below.

Slatted floor with perforated strips

Cowsheds usually have concrete slatted floors. Cows can move freely in the barn, and manure and urine fall on the slats and end up in the manure pit under the hollow floor. Ammonia is formed in the manure pit and on the slatted floor. This evaporates and remains in and around the barn.

With Lely Sphere, the gaps in the slatted floor are sealed with perforated metal separation strips. The urine runs out through the holes in these strips, while the manure remains above. This principle can be used in new barns, but existing barns with slatted floors can also be fitted with separation strips without the necessity for any major intervention.

Manure robot to keep the floor clean

In barns fitted with the Lely Sphere system, the floor is regularly cleaned by a manure robot. This independent device sucks up the manure that remains on the floor and deposits it into a discharge opening. The manure then ends up in the manure pit under the barn. Manure and urine can be allowed to mix in the pit, or can be kept separate. Ammonia is still produced, but it is extracted.

Ventilation with pit extraction

The Lely Sphere N-Capture extracts air from the manure pit and blows it out through a filtering system. This air displacement creates a vacuum pressure in the pit, which in turn sucks the air from the barn just above the perforated floor into the pit. The floor therefore acts as an extractor hood. The small amount of ammonia that can still form





above the floor disappears down through the holes. Other manure gases, such as hydrogen sulphide (H_2S) and methane (CH_4), are also extracted in the same way. This creates a more pleasant and safer climate in the barn for people and animals alike.

The ventilation under the floor directs the air through the manure pit to the ammonia filter. This air flow promotes the evaporation of ammonia in the manure in the pit. This is useful, because if more ammonia is passed through the filtering system, more nitrogen can be extracted from the manure.

Filtering system to reuse ammonia

The filtering system is comprised of a column of structural blocks through which an acidified liquid drips. The ventilation air is passed through this column. When the air comes into contact with the liquid, the ammonia dissolves and reacts with the acid. The ammonia-nitrogen is left behind in the wash water in the form of ammonium (NH_4). The saturated wash water is stored as circular liquid chemical fertiliser.

The fans and the ammonia filter are automated. The system is optimised to capture as much nitrogen as possible with the lowest possible energy consumption. Recycled ammonia-N can be stored, so the performance of Lely Sphere can always be demonstrated and verified by third parties.

Dairy barn before and after installation of the Lely Sphere

Before installation (1) Cows walk on a slatted floor. (2) Manure and urine fall to the floor and pass through the slats into the manure pit below. (3) Ammonia is formed where urine and manure mix, both on the slatted floor and in the pit. (4) This ammonia enters the barn atmosphere (5) and is dispersed into the surroundings by natural ventilation.

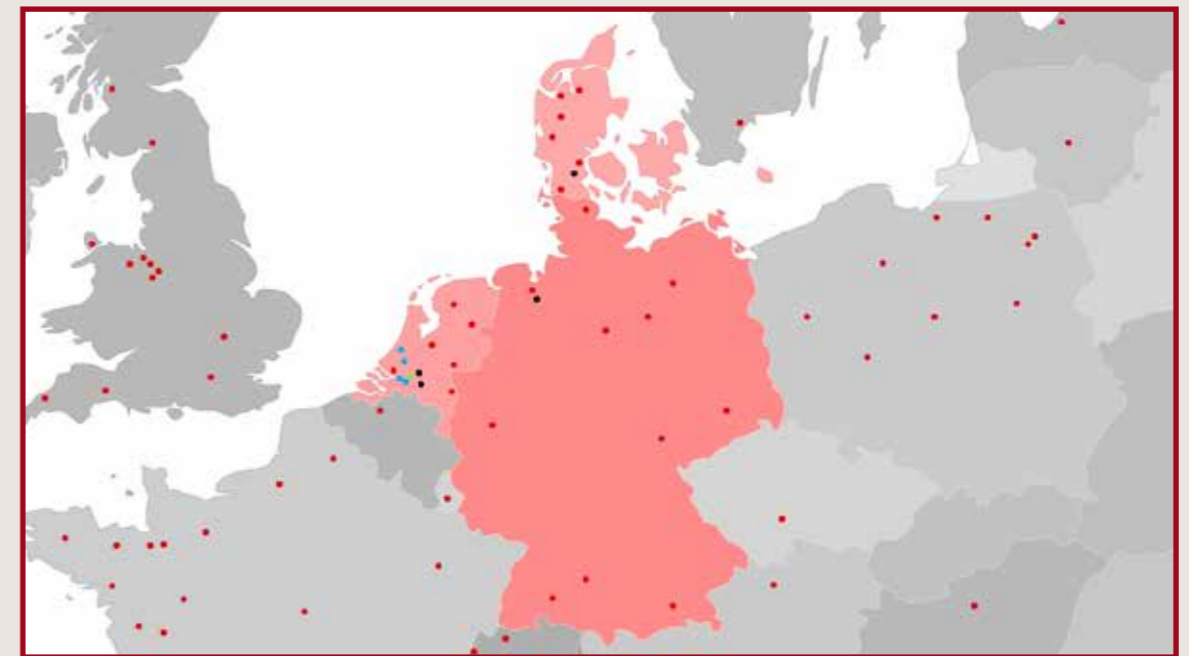
After installation (1) Cows walk on a perforated floor. (2) The urine flows into the manure pit, the manure remains on the floor. (3) The manure is sucked up by the robot and deposited separately into the manure pit. (4) The separation of manure and urine means barely any ammonia is formed on the floor. (5) The N-Capture extracts the ammonia from the pit and from just above the floor, removes the ammonia from the ventilation air and converts it into a substitute for chemical fertiliser. The filtered air flows out through the N-Capture. Natural ventilation in the barn is maintained, but nitrogen emissions are reduced by approximately 70%.

Target group and markets

Dairy farmers in Western Europe and the rest of the world

Lely has been working on this idea since 2015. Since mid-2017, the system has been tested in practice on six test farms (DE, DK and four in NL). Following the LIFE project, the results will be validated at nine other pilot farms, so that the product can be scaled up and prepared for the market.

Initially, dairy farmers in Western Europe are the main target group. The measures around ammonia and nitrogen in this region are the most urgent. However, the system will be introduced more widely, since closing loops and improving the use of nutrients is crucial for the dairy farm of the future everywhere in the world.





Benefits in the EU

Environmental objectives concerning ammonia

This project is in line with Article 10 of the LIFE Environment Programme: 'Environment and Resource Efficiency'. Lely Sphere can be beneficial in the EU in various ways. In the first place, the potential reduction in ammonia emissions is important for achieving various environmental objectives. Dairy farming is responsible for a relatively large share of ammonia emissions. In the EU, the agricultural sector is responsible for 94% of total ammonia emissions (Eurostat EU-27, 2010). That represents 3,364 kilotonnes of NH_3 per year. Dairy farming is responsible for 47% of this (Eurostat, 2016).

Climate Action

Lely Sphere's technology for limiting emissions also reduces the emission of other harmful gases, such as the greenhouse gases methane (CH_4) and nitrous oxide (N_2O). In accordance with the EU plan on Climate Action, greenhouse gas emissions must be reduced by 20% by 2020 compared to 1990.

Greenhouse gas emissions of N_2O and CH_4 per year are currently the equivalent of 470.6 million tonnes of CO_2 . 47% of this, or 221.2 million tonnes, is caused by dairy cattle. If a market share of 100% can be achieved in the EU-28, a decrease equivalent to more than 220 million tonnes of CO_2 can be achieved.

Circular economy

The reuse of ammonia nitrogen as a substitute for chemical fertiliser on the dairy farm reflects the ambitions set out in the European Commission's Circular Economy Action Plan. It is also in line with the proposals of the European Commission of 17 March 2016 to stimulate the use of organic and waste-based fertilisers.

This project concerns the reuse of nitrogen from ammonia. Further processing of manure allows nutrients to be used even more efficiently and specifically in the future for growing crops and improving soil. Dairy farmers can exploit precision fertilisation and robotisation technology to further refine fertilisation. Light, autonomous vehicles can apply small doses of fertiliser at frequent intervals. For example, Lely is working on the development of Lely Exos, an autonomous vehicle that can harvest fresh grass and feed it to livestock. This vehicle can also help apply liquid fertilisers to freshly cut grassland.

Contact details

Contact person:

Esther Lelij | International Marketing & Communications | Corporate Communications Manager

Tel: **+31 (0)88 1228221**

Mobile: **+31 (0)6 8253 6989**

Email: elelij@lely.com + life@lely.com

Lely Industries N.V.
Cornelis van der Lelylaan 1
3147 PB Maassluis
The Netherlands

Project website www.lely.com/emissions

https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=6208

Project costs

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