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Nitrogen Emissions

**WORLD FOOD PRIZE 2025**  
**IMPACT OF NITROGEN EMISSIONS IN THE NETHERLANDS**

The Netherlands is a critical country because of its impact on trade, technology, culture, and agriculture. It's strategically located in western Europe, allowing it to be one of the busiest ports, serving as an entrance to Europe. It has also played a huge role in water management in agriculture. Due to a majority of the country being below sea level, they run into many issues regarding flooding and groundwater, and excessive nitrogen emissions. Although these cause difficulties, it allows the country to be resourceful and innovative, therefore inventing new efficient ways of agriculture. (Tulis P. 2023)

Over half of the Netherlands is farmland. The Netherlands is one of the biggest competitors in agriculture, behind China and the U.S. A significant amount of the Netherlands' land is dedicated to agriculture. Not only does the Netherlands produce an overwhelming amount of food products, but they also supply many Dutch colonies and islands with the food they produce. Much of the land is strategically managed through a system of canals that allow for thorough irrigation throughout the nation. These systems are not only agriculturally beneficial, but some of them are beautiful and marked as Dutch landmarks. (Reiley L. 2022)

The typical family size in the Netherlands is 2.18 people per household. Most families live in townhouses that are built wall-to-wall. The diet of a typical Dutch family consists of a majority of meat, bread, potatoes, and a variety of grains and vegetables. The average Dutch diet makes it extremely important for the Netherlands to maintain efficiently growing crops with as little food insecurity as possible. Taking additional islands in the Dutch kingdom that the Netherlands provide food for into consideration also dramatically increases the importance of their agriculture. (expatica, 2024)

In the Netherlands, men and women are mostly equal in the workforce. The Netherlands is known for its high employment and equal work ethic. Some common jobs in the Netherlands are engineers(8-9%), IT professionals, and healthcare workers (15.3%). Some of the best jobs in the Netherlands are in the IT field. The average salary in the Netherlands per month for a full-time worker is \$3,317 a month, \$12.79 an hour for an average 9-5 job. (Wittenborg, 2023)

The percentage of Dutch women with a college degree is significantly higher in the Netherlands with 60% of Dutch women having a bachelor's degree or above, slightly over half of the men. Healthcare in the Netherlands is managed by the government and supplemented by private insurers.

Healthcare is about \$106-212 out of pocket, which is below the average of European healthcare pricing and much lower than the US average of healthcare. (Riley L, 2022)

Nitrogen emissions in the Netherlands significantly affect agricultural productivity, household income, lives of Dutch islanders, and food quality. Excessive nitrogen, often emitted from animal manure and livestock, can positively impact crop yields in the short term. Over time it can cause nutrient imbalances, acidifying soil, and may harm overall health. This may decrease agricultural productivity and may require farmers to invest in expensive soil amendments or costly water treatment. In livestock farming, stricter regulations to reduce nitrogen emissions can be set in place, such as limiting herd sizes, which can also lower the output of nitrogen emissions, although this directly impacts farmers' incomes, particularly regarding dairy production.

In households, these issues may cause higher food prices and possible shortages of certain agricultural products in areas heavily impacted by these nitrogen emissions. This is because if nitrogen leaches into bodies of water, it may deplete oxygen levels and affect the water quality used during irrigation. This would reduce crop yields and production, therefore making finding food much more difficult. The Netherlands also still provide food and products to the islands and several territories that are included in the Kingdom of the Netherlands. If the Netherlands are experiencing food insecurity stemming from excessive nitrogen emissions, this will directly impact their daily lives due to the eventual lack of proper food shipment. In the long term, balancing nitrogen emissions from livestock manure is crucial to maintaining environmental and economic stability to ensure affordable and edible food for consumers.

Excessive nitrogen emissions in the Netherlands have both a direct and indirect impact on the typical Dutch family, predominantly regarding food prices, food quality, and household income. The Netherlands is an important agricultural producer and the nitrogen emitted from livestock is a necessity to maintain success in the country's agricultural economy. However, there are many issues caused when there is an excessive amount of nitrogen being produced. These issues include soil degradation, water pollution, and loss of biodiversity in the ecosystem. All of these issues have led to much stricter regulations in Dutch farming. (Hawaii Department of Agriculture, 2023)

For a typical Dutch family, one of the most immediate impacts is the increase in food prices. As farmers face more issues and have to enforce stricter regulations on their farms, this may be very costly, therefore raising the prices of their products. This impacts household budgets and food quality. In particular, this may affect families who struggle financially or larger families who spend a larger proportion of their income on food for their families. Although these excessive nitrogen emissions are an issue, agricultural engineers are finding ideas to reduce nitrogen, although it may be costly. If farmers face financial issues and strain because of these nitrogen reduction practices, it may affect employment in rural areas, possibly impacting the income of families with family farms.

The issue of excessive nitrogen emissions in the Netherlands remains a significant challenge, both environmentally and economically. The nitrogen levels in the Netherlands are among the highest in Europe, due to its intensive livestock farming and use of fertilizers. These emissions affect soil, water contamination, and lower crop yields, all of which contribute to serious economic damage.

In response to these issues, the Dutch government has enforced strict practices that should reduce excessive nitrogen levels. These practices include limiting the amount of livestock and regulating the amount of fertilizer that is used on farms. In 2019, a court ruling concluded that the Netherlands must reduce its nitrogen emissions to abide by European environmental standards. This resulted in a huge decline in emissions; it is predicted to lower nitrogen emissions by as much as 50% by the year 2030. These ordered policies allow farmers to adopt more sustainable farming practices like precision farming and the usage of low-emission technologies.

Although these ideas may sound completely beneficial, many farmers would disagree. Many farmers, particularly those involved in livestock farming, are protesting against these measures. They argue that the regulations are impacting their livelihood and the amount of annual production. This is heavily affecting their wage and is creating tensions between farmers and the government.

Nitrogen emissions in the Netherlands have been a consistent challenge, but these trends have been very mixed recently. The agricultural sector of these nitrogen emissions is struggling to reduce them. Ammonia and nitrogen oxides are the largest factors that contribute to excessive nitrogen production. Despite sustainable farming measures being practiced, and the reduction of livestock, these emissions have remained higher than what is accepted. A large cause for this is the resistance of farmers to take these measures.

The Netherlands has made significant progress in limiting its nitrogen emissions, but it has not been enough. The country is one of the leading sources of nitrogen emissions in Europe. This continental issue has resulted in more serious precautionary measures being taken. In 2019, the government implemented more extreme laws in the Netherlands to regulate their excessive nitrogen emissions. While the levels of nitrogen have been slowly decreasing, it still does not meet European standards, continuously leading the continent in emissions of ammonia, nitrogen oxides, and nitrogen. If the Netherlands continues to practice these protective measures, the nitrogen levels will eventually decrease and plateau to a regulated level. Once these emissions stabilize, they are predicted to work towards a more long-term goal like maintaining these levels and balancing the economic struggles that these protective measures may cause.

Improving nitrogen emissions would be not only beneficial to the Netherlands but to the entire continent of Europe. The Netherlands is the top contaminator of nitrogen and ammonia in Europe.

This is due to its vigorous livestock farming and use of manure. When animal waste (particularly livestock) is excreted, it releases a various amount of toxic substances into the atmosphere, the biggest issue being nitrogen. Nitrogen isn't directly released from animal waste, but it is the product of the combination of other toxic substances released as well. The manure that is used is just another example of animal waste that is emitting nitrogen into the atmosphere of the Netherlands.

Once these protective measures are consistently used and the nitrogen emissions have stabilized, soil acidification, water eutrophication, depleted oxygen levels, and damage to biodiversity will all be improved. Not only will the environment and livelihood of people be improved, but the economy will improve as well because the prices of crops will decrease due to an ease in labor with the lack of nitrogen. The benefits of these reduced nitrogen levels affect the ecosystem as well. Once the levels have stabilized, the ecosystem will gain its diversity again. This is because the ammonia and other toxic chemicals released are extremely harmful to many species in the Netherlands and Europe. Nitrogen leaches into the waterways, contaminating the water, and many plants are killed and lost due to soil acidification once the nitrogen reaches the soil.

An efficient and unique way to limit the amount of excess nitrogen emissions in the Netherlands is to use photocatalytic materials to break down toxic nitrogen emissions and purify the air. Local governments can assist in using photocatalytic materials to limit nitrogen levels. Photocatalytic materials, such as titanium oxide are extremely efficient in eliminating the air of toxic pollutants, such as nitrogen. When they're exposed to UV light, they develop a chemical reaction that converts the toxic NO<sub>x</sub> gasses into harmless nitrogen or oxygen. This can also be known as photocatalytic NO<sub>x</sub> removal. Local governments can assist this by placing green roofs that have these photocatalytic materials on top of buildings and urban areas. A photocatalytic coating on infrastructure can send these substances into the atmosphere, therefore eliminating a significant amount of toxic nitrogen emissions. The national government can assist as well by setting policies and laws that require urban areas to have some of these photocatalytic materials. National enforcement of these laws is necessary to maintain these standards and consistently use the materials for the better of the country. Community organizations can contribute as well because people in communities who care about these nitrogen emissions will create groups that can help. These groups may either use these photocatalytic materials to limit nitrogen levels or come up with alternative solutions to the issue.

Using photocatalytic materials can positively affect local families because the air quality will be improved, and there will be less pollution; these would all result in a reduction of public health concerns and the livelihood of the Dutch people. This is because Nitrogen compounds can play a huge role in the contribution of respiratory issues. This directly affects families, particularly the elderly and children. The reduction of nitrogen levels in the atmosphere can directly improve the quality of life, leaving Dutch families dealing with fewer health problems. Local families can support these ideas by adopting these practices. They can easily do this by limiting how often they

use their car or other harmful transportation. Supporting and publicly advocating for these ideas helps as well because it can influence others to support these ideas.

The use of photocatalytic measures to reduce excessive nitrogen emissions can help address food insecurity because it improves the air and soil quality, which are huge factors in successfully growing crops to eat. Once these emissions have been lowered, it will make farming much easier and it will drastically increase the quality and amount of food and crop production. Not only will the use of photocatalytic materials increase the amount of food being produced, but because of supply and demand, the prices will lower as well. All of these factors will make food more accessible all over the nation, from family farms to urban supermarkets. The reduction of nitrogen emissions as a result of the consistent usage of photocatalytic materials will also improve the continent's food insecurity because the Netherlands is one of the largest contributors to nitrogen emissions in Europe.

The Green Roofs are another initiative where photocatalytic materials are used and incorporated into urban areas and architecture in order to achieve the nation's goal of reducing excessive nitrogen emissions. Green Roofs involve building and planting gardens on rooftops of buildings. These gardens can also be planted on walls and the sides of the buildings, not just the top. The way that photocatalytic materials are incorporated into this project is that there will be photocatalytic coatings around the gardens to break down nitrogen in the atmosphere, as well as other toxic pollutants. These roofs will also help absorb water, therefore benefiting stormwater management and energy efficiency. Depending on what plants are being grown on these green roofs, it could also help restore the biodiversity that was lost in the past due to the excessive nitrogen levels leaching into the soil, depleting plants of nutrients, therefore killing them.

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