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# Agriculture and Water Quality: Balancing Economic and Environmental Priorities in the Netherlands

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# AGRICULTURE AND WATER QUALITY: BALANCING ECONOMIC AND ENVIRONMENTAL PRIORITIES IN THE NETHERLANDS

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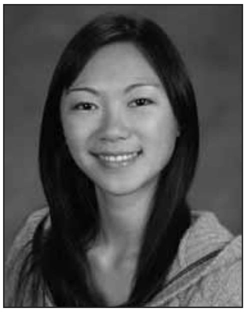


## Introduction

Agriculture[1] has always had a strong presence in the Dutch economy. In 2004, the Dutch agro-sector had a 9.4 percent share of the Dutch Gross National Product (GNP). ("Facts and Figures . . . ," p. 10) The Dutch "agro-sector" is a general term that describes all economic activity that involves primary and secondary production. Primary production describes the production of "raw" products from agriculture and accounts for 1.7 percent of Dutch GNP, while secondary production involves the processing of these commodities to be exported as "finished" goods.[2] Agricultural exports from the Netherlands made up 7.4 percent of global agricultural exports in 2005 ("Facts and Figures . . . ," p. 13), making the Netherlands the second largest exporter of agricultural products in the world by value.

Lately, Dutch agriculture has seen a trend toward increased intensity (more production per hectare of farmland) and larger farm size, while the actual number of farms is decreasing. ("Facts and Figures . . . ," p. 21) The increased intensity of Dutch agriculture puts a strain on water resources. The input of nutrients like nitrates and phosphates to water systems as a result of agricultural activity undermines water quality. Agriculture is the largest source of nutrient pollution in the Netherlands. (Fraters et al., p. 9) Moreover, the input of nitrates into ground and surface water is a difficult problem to mitigate since it is not easy to pinpoint one particular source.

[1] "Agriculture" in this article will be used as a general term that refers to all forms of primary production, including livestock farming, dairy farms, glasshouse farms, and horticulture (vegetable and ornamental plant production).

[2] E.g., milk powder.

A high concentration of nitrates in drinking water is detrimental to human health. For groundwater sources of drinking water, the main concern is the leaching of nitrates into the groundwater from agricultural land. The World Health Organization has defined a safe level of drinking water as one containing less than 50 mg/L of nitrates (“Nitrate and Nitrite . . . ,” p. 23), and this is the standard that is currently set by the EU in the EU Nitrates Directive. High concentrations of nitrates in drinking water can result in methemoglobinemia[3] in infants. In adults there is an increased risk of contracting rectal, colon, and bladder cancer as well as non-Hodgkin’s lymphoma. Eutrophication of surface water can also undermine public health. Eutrophication occurs when high nitrate concentrations in surface waters lead to rapid reproduction of algae in the water. When the algae die, the decomposition consumes excess amounts of oxygen in the water, choking other life forms in the water and exposing the surrounding communities to toxins produced by the algae and putrid smells. (“Eutrophication and Health,” p. 12)

The Netherlands has made an earnest effort to decrease the nitrate input into its water systems. The EU Nitrates Directive of 1991 requires all member states to designate “Nitrate Vulnerable Zones,” or areas where land use results in an elevated transportation rate of nitrate into local bodies of water, resulting in pollution. (“Council Directive 91/676/EEC”) While the Netherlands has not formally designated Nitrate Vulnerable Zones, it has launched action programs that are geared toward decreasing nitrogen output from agricultural activity in the country as a whole. (Fraters et al., p. 7) The Netherlands is currently in its Third Nitrates Action Program, a result of the OECD Environmental Performance Survey in 2003 that stated that the Netherlands has not performed satisfactorily in reducing nitrate levels in shallow groundwaters 0 m. to 5 m. below the ground surface. Since nitrate remains in groundwater for a long time, there is a time lag between the implementation of an action program and the results seen from those programs. Thus, it may take the Netherlands several years to meet the standards set by the EU.

In this article I discuss how the increasing awareness of the adverse health effects of agricultural effluents into water systems is driving the Netherlands to adopt the standards set by the EU. I focus primarily on nitrate inputs into ground and surface waters and how this affects drinking water quality. I also discuss how the Netherlands can ensure compliance with the various EU directives that have been passed — specifically, directives pertaining to nitrate concentrations and drinking water quality. Are the standards and restrictions implemented detrimental to the agricultural contribution to the economy? Is there some sort of middle ground where the competitiveness of the Dutch agricultural sector can be maintained while keeping the input of nitrates into the water systems to a minimum?

## Facts and Figures about Agriculture in the Netherlands

According to a 2005 survey by the Ministry of Agriculture, Nature and Food Quality, 1.9 million hectares,[4] or 52 percent of the total land surface of the Netherlands, is cultivated land. This is a significant amount of land, considering that the total production value of the agriculture sector in 2005 (€18.6 billion) made up only about 1.7 percent of the GNP of the Netherlands, as noted earlier. (“Facts and Figures . . . ,” p. 23) However, this share is still slightly above the average of 1.6 percent of GNP for other European countries. The graph below shows the relative share of production value by agricultural sector in the Netherlands.

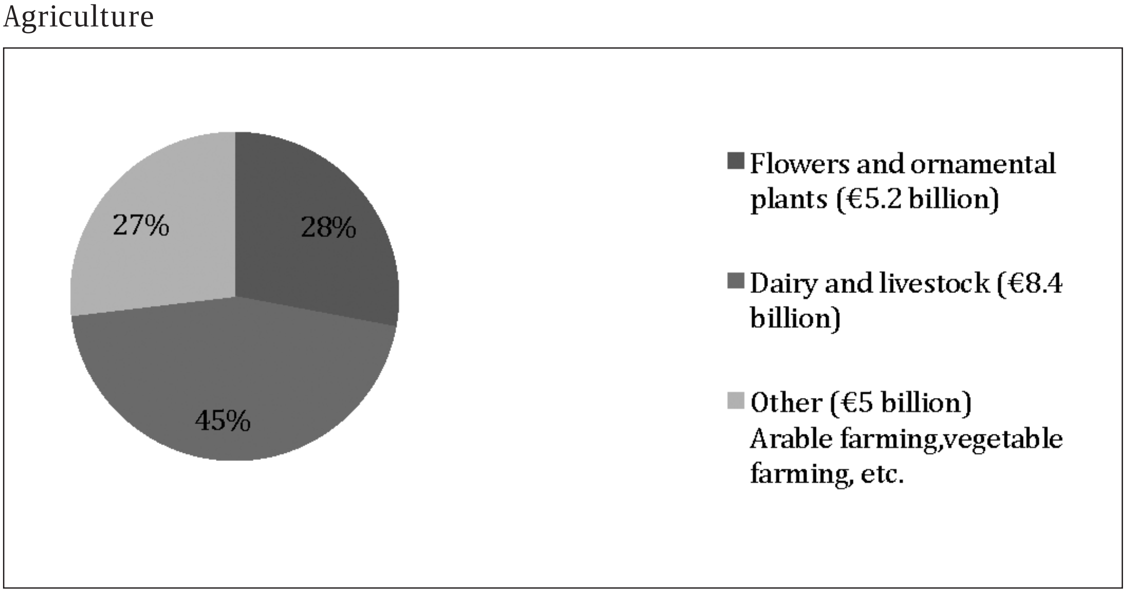
Dairy and livestock account for the highest share of the production value from agricultural activities; they also make up the largest share of the 81,830 farms in the Netherlands, at 58 percent. The annual economic growth in the agricultural sector was only 0.6 percent, compared to the national average economic growth rate of 3.2 percent. (“Agricultural Economic . . . ,” p. 7)

[3]Methemoglobinemia, better known as “blue baby syndrome,” reduces the oxygen-carrying capacity of the blood and can be lethal in some cases.

[4]About 5 million acres, or 7,500 square miles.

**Figure 1**

**Share of Total Production Value From Agriculture**




*Source:* "Facts and Figures . . . ," p. 23.

The latter part of the twentieth century has been characterized by expansion and increasing intensity and productivity in Dutch agriculture. ("Facts and Figures . . . ," p. 21) However, the number of Dutch farms has actually decreased by a third since 1990. This is due to the emergence of "mega farms." A typical mega farm is about six times the size of an average farm. ("Facts and Figures . . . ," p. 21) In 2004, the Netherlands had 1350 such farms, totaling 17 percent of total production value. Agriculture employs about 2.5 percent of the Dutch population, mostly in rural areas. However, the number of agricultural workers has declined 18 percent from 1991 to 2005. ("Agricultural Economic . . . ," p. 7)

## Agriculture's Impact on Water Resources and the Subsequent Effects on Human Health

Agriculture is the biggest domestic contributor of nitrate into the water system. The intensification of agriculture in the Netherlands has only exacerbated the problem. Sources of nitrate include chemical and organic fertilizers (manure) and excreta from farm animals. Nitrate is soluble in water, and there are two mechanisms by which nitrate enters the water system. One way is by leaching into groundwater, where nitrate is transported from the soil surface by gravity to the groundwater. Another process is through runoff into surface water which occurs during high periods of rainfall; the rain runs off the saturated ground and transports dissolved nitrate into streams.

Table 1, adapted from the 2004 draft of the report to the European Commission, summarizes the nitrate concentration in groundwater and surface water for the period from 2000 to 2002. The numbers in the table show the average measured concentration of nitrate in ground and surface waters taken at several monitoring sites spread out over the country. The percentages in parentheses indicate the proportion of monitoring sites that exceed the EU Nitrates Directive Standard of 50 mg/L. Generally, nitrate concentrations decrease with depth in the groundwater, and they also decrease with the distance from agricultural land.

## Table 1

### Average Measured Nitrate Concentration in Groundwater and Surface Waters for the 2000–2002 Period

| | Sand | Clay | Peat |
|---|---|---|---|
| Shallow groundwater, 0 m–5 m below soil surface (agricultural) | 75 mg/L (66% of monitoring sites exceeding 50 mg/L) | 40 mg/L (30% of monitoring sites exceeding 50mg/L) | <5 mg/L (0% of monitoring sites exceeding 50mg/L) |
| Groundwater 5 m–15 m below soil surface (agricultural) | 40 mg/L (21% of monitoring sites exceeding 50mg/L) | <5 mg/L (0% of monitoring sites exceeding 50mg/L) | <5 mg/L (0% of monitoring sites exceeding 50mg/L) |
| | Average nitrate concentration | | |
| Agriculturally-influenced surface waters | 15 mg/L (3% of monitoring sites exceeding 50mg/L) | | |
| Other regional water | 14 mg/L (1% of monitoring sites exceeding 50mg/L) | | |

*Source:* Fraters et al., p. 11.

Table 1 shows that shallow groundwater sources in sandy soils near agricultural land have an average concentration of 75 mg/L, with about two thirds of monitoring sites exceeding the EU Nitrates Directive Standard of 50 mg/L. Groundwater is the main source of drinking water for most water companies in the Netherlands. Consumption of water with high nitrate concentrations has been linked to diseases such as methemoglobinemia (blue baby syndrome), especially in infants under three months of age. This is believed to the result of an enzyme deficiency in infants under three months of age. About 98 percent of clinical studies on the adverse health effects of nitrate in drinking water have found a strong relationship between the occurrence of methemoglobinemia and nitrate levels of 44.3 mg/L or higher. (“Nitrate and Nitrite . . . ,” p. 11) Thus, shallow groundwater sourced from sandy soils that is used for public consumption could result in elevated occurrences of methemoglobinemia, especially in young children, if not treated properly. In adults, high nitrate concentrations in drinking water have been linked to increased risks of contracting bladder cancer, colon and rectal cancer, non-Hodgkins lymphoma, and inflammatory bowel disease.

Referring again to Table 1, the average concentration of nitrate in agriculturally influenced surface waters is 15 mg/L, three percent of which exceed the EU Nitrates Standard. Agriculture accounts for 60 percent of the domestic contribution of nitrate into the surface water. High nitrate concentrations lead to eutrophication of surface waters, which poses a significant threat to human health: the cyanobacteria that break down the dead organic matter in the water produce toxins that target the liver, skin, and nerves in animals. (“Eutrophication and Health,” p. 12) Exposure to the toxins through drinking the contaminated water, through direct contact with the contaminated water, or through inhalation can cause one to become severely ill.

Incidences of these diseases in the Netherlands have led to a drop in consumer confidence in the quality of the finished water that arrives in consumers' taps. Indeed, as it is with some other European countries like Belgium, most restaurants in the Netherlands offer bottled water to customers, never tap water. In the Netherlands, there are few satisfactory methods for water companies to treat water that contains nitrate. One way of doing so is to dilute the contaminated water with another water source that contains a lesser concentration of nitrates. If dilution is not feasible, other methods like ion exchange[5] (for groundwater) and biological denitrification[6] (for surface waters) are used to remove nitrates from the water. ("Nitrate and Nitrite . . . ," p. 15) However, these are expensive and labor-intensive methods. The best way to control nitrate contaminations in water sources, especially in groundwater, is the prevention of contamination by introducing "good agricultural practices" to farmers in the form of the EU Nitrates Directive and the EU Drinking Water Directive.

## Applying EU Standards on a Local Level

The EU Nitrates Directive was passed on December 12, 1991, and its purpose was to "reduce and prevent water pollution due to nitrates from agricultural sources." ("Council Directive 91/676/EEC") Under this directive, member states are required to indicate the steps they have taken to limit the use of organic and inorganic fertilizer in agriculture. Member states also have to designate Nitrate Vulnerable Zones, defined as territories which contribute to the pollution of water systems. ("Council Directive 91/676/EEC") After designating these zones, the member states must implement action programs to reduce the nitrogen inputs to 170 kg of nitrogen for every hectare of farmland[7] in these areas within two years of notifying the Commission of the location of the designated areas. These action programs will consist of manure management plans, fertilizing schedules, and "good agricultural practices" which take into consideration soil type and conditions, climate, and land use. Member states also have to monitor their waters and submit a progress report every four years to the European Commission. Currently, the Netherlands has no formally defined Nitrate Vulnerable Zones; the national government has applied an action program to the entire national territory.

The EU Drinking Water Directive was passed on November 3, 1998, and its objective was to "protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean." ("Council Directive 98/83/EC") The EU Drinking Water Directive defines a maximum concentration for nitrate in drinking water to be 50 mg/L, in accordance to WHO guidelines. However, every five years the Commission reviews and, if necessary, amends the standards that were laid out in the Directive in light of new scientific and technical progress. Member states are also responsible for monitoring their water resources and must submit a progress report to the Commission every three years. Note that the report for the EU Drinking Water Directive only concerns water used for drinking water resources, while the report for the EU Nitrates Directive pertains to all water systems in the Netherlands.

Taking these two directives into account, the national government of the Netherlands launched an innovative system in 1998 called the Mineral Accounting System (MINAS). (Fraters et al., p. 7) Through MINAS, farmers have to document a mineral balance based on inputs and outputs of nitrate on their farms; somewhat like accountants documenting the inputs and outputs of cash flow on a balance sheet. Inputs come from fertilizers and animal feed while outputs come in the form of agricultural products and the disposal of manure. The difference between inputs and outputs (usually a surplus) is taken as an approximate indicator of how much nitrate is being lost to soil. Farmers who exceed the maximum surplus of 170 kg/ha are subject to a levy (tax) that is determined by the amount that the surplus exceeds the maximum of 170 kg/ha. In 2002, a Mineral Transfer Agreement System (MTAS) was

[5]Ion exchange removes nitrates from the water by chemically bonding the nitrate anion (a molecule that has gained an electron and is negatively charged) that is moving freely in solution with a positively charged cation (which is missing an electron), which is attached to a plate. ("Ion Exchange Chemistry . . .")

[6]Biological denitrification uses microorganisms to convert nitrate back into gaseous nitrogen, which is insoluble in water.

[7]170 kg/ha is about 150 pounds per acre.

added to MINAS to facilitate a mineral trading system, whereby farmers with too high a surplus could pay to transfer manure to a farm with a lower surplus. Under the MTAS system, the cost of trading each kilogram[8] of manure between farms is €0.78[9], much lower than the cost of manure disposal, which ranges from €8.50 to €15.50 per metric ton[10] of manure. (Berentsen and Tiessink, pp. 1–2)

In October 2003, the Court of Justice determined that the First and Second Nitrates Action Program (which included the MINAS-MTAS system) was not in line with the EU Nitrates Directive. ("Third Dutch . . . ," p. 3) In response to this, the Netherlands launched the Third Nitrates Action Program for the period from 2004 to 2009. This action program addressed the failures of the First and Second Nitrates Action Programs, particularly in outlining the application of fertilizers. Under the Third Nitrates Action Program, the application of manure and chemical fertilizers on sandy soils is prohibited from September 15 to January 31, when the ground is dry and most prone to soil leaching. The government hopes to gradually phase out by 2009 the application of organic and chemical fertilizers on all soil types between September 15 and January 31. Use of animal manure and nitrogenous chemical fertilizers on ground with a slope of 7 percent or more is prohibited in order to further prevent input of nitrate into surface water. Fertilizer-free zones must be established near streams and stream recharge areas. The widths of these zones may vary from crop to crop. The Dutch government also uses a quota system that reduces the intensity of farm production by restricting animal numbers and milk production. This has been more effective at reducing nitrate losses into the water system than the MINAS-MTAS system; as a result, the MINAS-MTAS system has officially not been used since 2006. (Heijmans)

Since the 1991 Nitrate Directive and 1998 Drinking Water Directive are just guidelines provided by the EU, the member states can modify them for their own purposes. While member states cannot exceed the values that have been defined in these directives, they can certainly make the requirements for compliance more stringent by raising the standards. For example, instead of requiring that all water systems have a nitrate concentration of less than 50 mg/L, the national government could raise the standard to 40 mg/L. Member states can also grant derogations (exemptions) from these directives, as long as such exemptions do not pose a threat to human health and if there are no other means by which to maintain the quality of the source. In 2006, a new manure policy was introduced in response to farmers who felt that the quota of 170 kg per hectare of nitrogen was too stringent. ("Agricultural Economic . . . ," p. 10) For farms that consist of 70 percent grassland area, derogation was granted whereby farmers could exceed 170 kg per hectare of nitrogen up to 250 kg per hectare (about 220 pounds per acre). This new policy is in effect until 2009 at the end of which a progress report will be written and submitted to the European Commission for review.[11] Currently, 80–90 percent of farms in the Netherlands have been granted derogations (Heijmans).

## Effect of Regulations on the Agricultural Industry

The regulations imposed by the Dutch government have incurred additional costs to farmers and the Dutch government alike. In 2005, six percent of total national environmental costs were due to mitigation efforts in agriculture. ("Agricultural Economic . . . ," p. 8) This is more than three times the share of agriculture's contribution to GNP. Much of this comes from administrative costs, such as paying scientists to monitor the water systems and training farmers to use the MINAS system. The MINAS and MTAS systems incurred administrative costs of €220 to €580 per farm in 2005. ("Surplus Nitrogen and . . .") The source of revenue for environmental mitigation partly comes from the levy that is imposed on farmers who exceed the maximum surplus of 170 kg/hectare of nitrogen. The rates vary from €1.15 to €2.30 per kilogram exceeded. After the discontinuation of MINAS and MTAS in

8 1 kilogram = 2.2 U.S. pounds.

9 €1 = U.S. $1.57.

10 1 metric ton = 2200 U.S. pounds.

11 The derogations typically do not last longer than three years, and can be renewed up to three times.

2006, quotas[12] imposed by the Dutch government further decreased the profitability and productivity of the farmers.

The increasing cost from the taxes levied by the government and the rising cost of land, as well as the inability of farmers to fertilize and reap as much from the land as possible, are all reducing production volume and raising costs of production. (Ratledge) According to the Agricultural Economic Report released by the Agricultural Economics Research Institute, the total production value of primary agriculture in the Dutch economy fell from five percent in 1970 to 1.7 percent in 2005. Until 1990, this decrease in production value was a matter of rising prices due to rising costs of agricultural land. After 1990, the growth in production volume has also lagged, most likely due to the more stringent standards imposed by the reformation of the EU Nitrates Directive. ("Agricultural Economic . . . ," p. 1)

However, the Dutch farmers' strategy has not been to campaign for lower taxes, but to market Dutch milk as a high quality product and ask for higher prices. (Ratledge, p. 83) Dutch farmers emphasize the fact that Dutch farms are clean, and therefore produce better quality milk. In her article, Ratledge observed the "aura of the Dutch farms [she] visited as very much one of food production, yet with the integrity and compassion to avoid any suggestion of factory farming." (Ratledge, p. 84) This has worked to the benefit of the Dutch, since this reputation has not reduced their competitiveness in the local and international markets; 70 percent of all dairy produce in the Netherlands is exported. Also, by improving the hygiene of Dutch farms, they become more appealing places to work, attracting new workers into the industry and reducing unemployment. (Ratledge, p. 84) Additionally, the LTO, or the Dutch Federation of Agriculture and Horticulture (which acts as the Dutch Farmers' Union), has been lobbying for less stringent standards and more space allotted for agriculture so that animal waste will not be so concentrated. (Heijmans)

[12]Quotas in this case refer to restrictions on animal numbers and milk production to decrease the intensity of production of farms.

## De Marke: A Step in the Right Direction

While agriculture still plays an important role in the Dutch economy, its intensification of production on a smaller land area in recent years has taken an environmental toll on water resources. Since livestock and dairy farms have the largest share of both production value and number of farms, careful attention must be paid to ensure that the nitrate wastes from these farms is dealt with in a way that ensures that the water systems are not harmed. Groundwater sources in particular appear to be severely affected, with about two-thirds of shallow groundwater sources in sandy soil exceeding the EU Nitrates Directive Standard of 50 mg/L. Thus, using the guidelines from the Third Nitrates Action Program to form a more holistic approach is essential toward reducing the amount of nitrate that enters the water systems while maintaining the productivity of the farm itself.

In 1987, research began on an experimental dairy farm that scientists hoped would change the future of farming in the Netherlands. The goal was to employ "good agricultural practices" to reduce the nitrate concentrations in the shallow groundwater to the EU standard of 50 mg/L, while keeping production numbers high. The farm milk production was to be in accordance to the quota system imposed by the government.[13] (Aarts et al., 2000, p. 234) The prototype of this experimental farm was called "De Marke," located in the Eastern Netherlands. The site is situated in dry, sandy soils which are prone to leaching, and groundwater occurs at 1 m to 3 m below the soil surface. Sandy soils are less fertile and thus more commonly used for dairy farming. Also, the fact that the site is prone to leaching means that the environmental problems here will be most pronounced, making this a worst-case scenario and an ideal prototype for nitrate management. Close to the farm is Oost Gelderland, a drinking water company that extracts about 1.3 billion gallons of groundwater annually[14] for human consumption. (Aarts et al., 2000, p. 233) The 55

[13]11,890 kg/ha per year, or about 11,000 lbs/acre per year.

[14]About 3.6 million gallons per day.

hectares of land[15] (which is typical for a dairy farm) was divided into permanent grassland (about nine hectares), and the rest was used for a rotation of grass and arable crops such as silage maize and beet. Italian ryegrass is sown between the rows of arable crops as a catch crop that prevents nitrate from leaching into the soil and into the groundwater table below.

The cows are put on a grazing schedule. In the summer months, the cows graze in the grasslands for two periods of four hours each. In between these periods and during the night, they are fed silage maize indoors. This ensures that the cows have a balanced diet of high protein (grass) and low protein (maize) foods. After October 1st of each year, the cows are corralled and kept indoors until warmer weather to reduce concentrations of nitrates in the form of dung and urine in the pasture. In addition, non-lactating cows (those that do not contribute to dairy farm production) are stall-fed. By comparison, the grazing time in commercial farms is twice as long, and the grazing season is one month longer. (Aarts et al., 2000, p. 234)

De Marke proved to be a valuable asset toward understanding the nutrient flows in a farm and how to implement the "good agricultural practices" that have been laid out by the national government. One of the most notable results is that the average nitrate content in the shallow groundwater region in the farm significantly decreased from 200 mg/L to below 50 mg/L in just five years. The concentration of nitrate in the groundwater of Oost Gelderland on plots close to De Marke was about four times that of the farm (Aarts et al., 2000, p. 238), possibly indicating that decrease in the concentration of nitrate had not yet taken place in areas outside of the farm. As for the productivity of the farm, the yields of maize and grass were eight percent to ten percent lower than that of commercial farms, but water was determined to be the limiting factor in determining the yield. The milk yield per cow on this farm was substantially higher than that of commercial farms: 8,200 kg/cow per year compared to the commercial yield of 5,500 kg/cow per year (in terms of the mid-1980s production average). Overall, the practices on this farm increased the cost of production of milk by an average of ¸0.02 per kg. (Aarts et al., 1999, p. 163) Since an average commercial farm produces 360,000 kg of milk annually, an increase of even ¸0.02 can be substantial.

Following the success of this pilot program, another program titled "Cows and Opportunities" was launched in 1998, with17 commercial dairy farms implementing the methods of De Marke to better manage nitrate leaching. (Aarts et al, 2000, p. 240) These pilot farms represented a variety of different soil conditions in order to provide a full range of data. The farmers also received research and advice from the scientists who had worked on the De Marke prototype farm. Once implemented, the pilot farms had more land and produced more milk per hectare than the average Dutch dairy farm. (Langeveld et al., p. 369) As the project progressed, the productivity surpassed that of any comparable farms that were not involved in the project, while keeping nitrate levels in shallow groundwater low. With more and more farmers implementing this system the Netherlands will easily be able to achieve its goal of complying with EU standards.

## Conclusions

From 1990 onwards, the increasing awareness of the adverse health effects of high nutrient loads in water systems has led the Dutch agro-sector to reconsider its production intensive, high-profit model in favor of an environmentally friendly, albeit less profitable one. The Netherlands has sought a long-term solution by launching two innovative programs: MINAS-MTAS and the prototype farm De Marke. National and global agricultural research has used MINAS and De Marke as launching pads for research on methods of reducing nitrate levels on farms using a more holistic approach. However, while the nitrate surplus system in MINAS managed to provide a good estimate of the input of nitrate into the groundwater system, it did nothing to decrease the amount of nitrate going into water systems.

In 2006, the Netherlands abandoned MINAS and focused instead on tackling the problem at the source, by encouraging "good agricultural practices" among farmers as outlined in the Third Nitrates Directive. By restrict-

[15]About 135 acres.

ing the use of fertilizers and decreasing the production intensity of farms (less produce per hectare), nitrate losses into the soil could be decreased. The De Marke prototype farm was a pioneer in implementing these measures well before the Third Nitrates Directive was written in 2004. Preliminary research has shown the practices on De Marke to be very effective in reducing nitrate inputs into shallow groundwater, but the costs and the need for skilled labor for such a farm were a problem. Thus, more research needs to be aimed at reducing the costs associated with running a farm like De Marke, since it has shown dramatic improvements in water quality in the shallow groundwater in just a short period of time.

While the stringent limits on fertilization have decreased production volume and taxes have resulted in higher costs on farmers, they have bounced back by turning the situation to their advantage, arguing that they have the right to impose higher prices on their produce since they take care to ensure a smaller impact on the environment. At this point in time, the reduction of nitrate in the water systems as a result of these new policies cannot be measured, since there is a lag time associated with the implementation of an action plan and the subsequent results. However, this only reinforces the fact that the stricter guidelines imposed by the current action plan will result in further reductions of the level of nitrate in the water systems. In fact, the LTO Secretary of Agriculture and Environment, Mark Heijmans, has projected that in 2010 the entire country will meet EU Nitrate Standards.

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