



Can intensive arable farming systems on sandy soils in the Netherlands meet the targets in the nitrate directive?

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Problem

- Nitrate leaching to ground and surface water on sandy soils are too high for EU Nitrate directive (50 mg NO₃/l⁻¹)
- Arable farming systems on sandy soils are intensive and with limited financial returns
- Large reductions in nitrate leaching made in last 20 years

Objective

- Development of integrated and organic arable farming systems which can comply with EU Nitrate directive

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Theoretical development of farming systems:

- Integrated system, six year rotation, two parts:
 - A: Fertilization with organic manure and chemical fertilizer
 - B: Fertilization with chemical fertilizers only
 Crops: potato, triticale, lilies, peas, leek, maize, sugarbeet
- Organic system, six year rotation
 - Crops: potato, alfalfa, leek, broccoli, maize, spring barley and tree nursery crops.
 - Only organic manure and no chemical crop protection

Important measures to reduce nitrate leaching:

- Efficient fertilization strategy based on crop uptake, taking into account uptake efficiencies, available mineral nitrogen
- Efficient fertilization techniques such as row fertilization (in maize and leek), split fertilization strategies (based on soil mineral N and crop reflection measurements)
- Use of catch crops where possible

Testing of these systems in the years 2005 until 2008



Sugar beet integrated system 18 July 2007 (above) and 30 June 2008 (below). Left side chemical fertilizer only; right side chemical and organic fertilizer

Table. Average results of the cropping systems 2005-2008

Cropping system	Nitrate concentration groundwater	Crop yield / Regional good crop yield	Total N input (fertilization, fixation, deposition, seeds, straw mulch)	Available mineral N for crop growth	N uptake / Available mineral N in uptake period
	mg NO ₃ /l ⁻¹	%	kg/ha ⁻¹	kg/ha ⁻¹	%
Integrated system A chemical and org. fertilizer	118	101	292	306	62
Integrated system B chemical fertilizer only	96	97	251	293	62
Organic system	42	104	296	243	61

Results and discussion

- The integrated system cannot comply with EU Nitrate directive because of:
 - many vulnerable crops (low N efficiency)
 - hardly any possibility for green manure crops
- Effect no use organic manure in the integrated system:
 - decreased nitrate leaching with 22 mg NO₃/l⁻¹
 - gradually decreased crop yields up to 5% loss at average in the latter two years
- Ratio of N uptake and available mineral N into the N uptake period of the crops is about 62%. This means a large amount of N available for leaching.

Solutions for further reduction of N-leaching

- Extensification
 - more pastures, cereals and catch crops
 - loss of income and employment
- New, desired catch crops
 - better establishment after late sowing
 - no propagation of plant parasitic nematodes
- Removal of N rich crop residues
 - sugarbeet, leek, broccoli, peas
- Use of drip irrigation and fertigation
 - may improve N-efficiency
 - higher net costs in most cases
- Outdoor vegetables on recirculating hydroponic systems
- Better soil management
 - physical, chemical and biological
 - good management practices need to be defined

Acknowledgements

This research was funded by the Dutch Ministry of Agriculture, Nature and Food Quality.

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