EFFECTS OF ORGANIC MATTER INPUT ON NITRATE LEACHING AND CROP YIELD IN ARABLE AND VEGETABLE CROPPING ON SANDY SOIL IN THE NETHERLANDS.

de Haan, Janjo[1], Verstegen Harry[1]

[1] Applied Plant Research - Wageningen UR
P.O. Box 430, 8200 AK, Lelystad, The Netherlands
janjo.dehaan@wur.nl

Background and Objectives

Organic matter in soils fulfills vital functions in many ways for food production. However, organic matter can give uncontrolled release of nitrogen leading to high nitrogen leaching to groundwater in periods without crop uptake. In arable farming on sandy soils in the Southeast of the Netherlands, this is one of the reasons of exceeding the standard of 50 mg NO_3^-/l in groundwater of the EU Nitrate directive. Average nitrogen concentration in groundwater is 79 mg NO_3^-/l, while only 21% of the farms is below the EU-standard (Hooijboer & de Klijne, 2012). Other important reasons for high nitrate concentrations in groundwater are the intensive arable and vegetable crop rotations with a large share of leaching sensitive crops and the relative high nitrogen and animal manure inputs (mainly pig slurry).

Two options are explored to reduce nitrogen leaching to groundwater: 1) No application of organic manure, causing less organic matter input and less nitrogen mineralization outside crop uptake periods and less nitrogen available for leaching to groundwater. 2) Organic farming with high organic matter input (cattle slurry and solid manure) and a lower total nitrogen input, causing more buffering of nitrogen in the soil. The question is how crop yields, nitrate concentrations in groundwater and soil quality are developing over time.

Materials and Methods

The options are tested on an experimental farm since 2001 in an intensive arable and vegetable six-year rotation. A comparison is made between three systems: 1) *system REG* with regular organic matter input from crop residues and animal manure, effective organic matter, (EOM) input about 1600 kg/ha, total N-input about 200 kg/ha; 2) *system MIN* with minimal organic matter input from crop residues only, EOM input about 900 kg/ha, total N-input about 170 kg/ha and 3) *system ORG* with an organic system with a higher organic matter input, EOM input about 2700 kg/ha, total N-input about 135 kg/ha. Since 2011, the crop rotation exists of the crops: potato, peas, grass (with clover in ORG), leek, barley, sugar beet (in ORG carrot) and maize. Nitrate concentrations in groundwater were monitored between 2005 and 2008 and in 2012. Crop yields were recorded every year. Chemical and biological soil quality parameters as nutrient contents, organic matter content, C/N-ratio, total N, available P, pH, CEC, fungal biomass, potential C and N mineralization, Hot Water Carbon and nematode groups were measured in 2011.

Results and Discussion

System REG has the highest nitrate content in groundwater, 120 mg NO_3^-/l on average in 2005-2008 and 66 mg NO_3^-/l in 2012. System MIN has a nitrate content in groundwater of 99 mg NO_3^-/l on average in 2005-2008 and 64 mg NO_3^-/l in 2012. The lower nitrate concentration in system MIN is caused by the lower EOM input in MIN. System ORG has the lowest nitrate content in groundwater,

the only one below the EU threshold of 50 mg/l with 39 mg NO_3^-/l on average in 2005-2008 and 30 mg NO_3^-/l in 2012. The lower nitrate concentration in system ORG is caused by the lower total N-input, more use of cover crops and probably a somewhat higher water table than in system REG. Differences between 2005-2008 and 2012 are caused by different weather conditions and difference in crop rotation. 2012 had a wet summer and autumn compared to 2005-2008. In 2005-2008 lily was in the rotation, in 2011 lily was replaced by grass.

Since 2007, crop yields tend to be lower in system MIN compared to system REG. Differences are varying strongly from no difference in 2009 and 2010 up to 10% in 2012. There are indications that the magnitude of the difference is correlated with rainfall in summer period. Dry summers give larger differences. Crop yields in system ORG tend to increase to the level of system REG: crop yields of leek, maize and peas are in 2011 and 2012 comparable to system REG. Crop yields of barley and potato in system ORG are still much lower than system REG because of disease problems.

Chemical soil parameters as organic matter content, total N, available P and CEC were little lower for systems MIN and ORG compared to REG but still in range for good production. Potential N and C mineralization were higher in system ORG compared to MIN and REG, indicating higher microbial activity. The biological soil parameters have a large variation and a clear visible trend in differences between systems is lacking.

Conclusions

No input of organic matter with fertilization and organic agriculture are both measures to lower nitrate leaching. Only organic agriculture can reduce leaching below EU-standards. Reducing organic matter input with manure reduces crop yields after six years. Therefore it is not an economic viable option. Organic agriculture with high organic matter input increases crop yield. It is difficult to make the differences in strategy visible in measurement of soil parameters.

Uncertain is how the trends of leaching, yield levels and soil quality will develop on the long term. Therefore, the research is continued in the next years.

Acknowledgements

The writers of the article wants to thank Marc Kroonen and staff of the experimental farm Vredepeel for their work in the experiment and the Ministry of Economic Affairs and two regional divisions of the Dutch Federation of Agriculture and Horticulture (ZLTO and LLTB) for their financial contribution to the project.

References

Hooijboer, AEJ, A de Klijne 2012. Water quality on farm lands. Evaluation of the Dutch fertilizer and manure policy 2012. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Rapport 680123001/2012. http://www.rivm.nl/bibliotheek/rapporten/680123001.pdf (in Dutch).