Determination of Groundwater-Protective Agricultural Management Systems Based on Long-term Modelling

Outline

Introduction, Background & Goals
Methods & Modelling
Results of Modelling
Conclusions & Summary
Background & Goals of Research

Yield, nitrogen/nitrate leaching losses → is cultivation sustainable & groundwater-protective? < 50 mg/l nitrate in seepage water of the unsaturated zone

The Wagna Research Field

Agricultural test site since 1987
32 lots with ca. 1000 m² each
8 crop rotations
Austrian Soil Map 1:25 000

Soil Types

- 40%: IS/Scho 4 D 35/39
- 20%: IS 3 D 47/50
- 20%: SL 2 D 64/67
- 20%: SL 3 D 54/56

Combined soil map (3 maps + additional soil profiles)

Detailed mapping

Intersection of
- lot
- soil type
- thickness of fine soil layers

⇒ 278 hydrotopes
Modelling – SIMWASER/STOTRASIM

SIMWASER – soil water balance/transport
STOTRASIM – nitrogen/nitrate transport

Meteorological parameters
Upper boundary conditions: precipitation, evapotranspiration
Lower boundary conditions: groundwater table or no water uptake by roots

Plant/crop & soil parameters
Cultivation/tillage (date, depths)

Modelling of nitrogen input, uptake by plants, ammonium sorption, mineralisation, nitrification, immobilisation, denitrification; nitrate leaching, groundwater recharge & dry matter (mean values & sums for each year 1993-2003)

Maize Single-Crop Farming

8 maize scenarios and their fertilisation amounts

<table>
<thead>
<tr>
<th>Fertilisation scenario</th>
<th>Nitrogen application [kg/ha]</th>
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</thead>
<tbody>
<tr>
<td>MM1 (Liquid manure + mineral fertiliser)</td>
<td>107</td>
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<tr>
<td>MM2 (Mineral fertiliser)</td>
<td>145</td>
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<tr>
<td>MM3 (Liquid manure + mineral fertiliser)</td>
<td>175</td>
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<tr>
<td>MM4 (Liquid manure)</td>
<td>107</td>
</tr>
<tr>
<td>MM5 (Liquid manure + mineral fertiliser)</td>
<td>163</td>
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<td>MM6 (Mineral fertiliser)</td>
<td>290</td>
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<tr>
<td>MM7 (Liquid manure + mineral fertiliser)</td>
<td>261</td>
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<td>MM8 (Liquid manure)</td>
<td>97</td>
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</tbody>
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Scenario Results: Yield, N, NO₃

Course of NO₃ Concentration
Groundwater Recharge & N Leaching

NO_3 Concentrations for 4 Soil Types
Conclusions & Summary

- Groundwater-protective for soils of intermediate depths (results of mean values of the entire research field):
  - MM1 (107), MM2 (145), MM4 (107)
  - Nitrogen load: < 40 kg/ha

- Groundwater-protective for soil types estimated by financial authorities:
  - MM1 and MM4 – all soils
  - MM2 – all soils except IS 3 D 47/50

- Groundwater-protective for soils of shallow depth:
  - fertilisation amounts up to 115 kgN/ha (liquid manure or mineral fertiliser)
  - fertilisation application: 50 % before sowing and 50 % into the crop
  - no fertilisation in autumn
  - winter catch crops (no legumes!) are necessary, tillage in spring

- Lysimeters are an important tool for obtaining information for model calibration and validation
  → help to determine sustainable agricultural cropping management systems