Modelling the N losses from intensive dairy systems in Portugal

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• The losses of N to the environment from intensive livestock production are a cause for concern.
• High livestock densities (up to 7 livestock units ha⁻¹) are common in the Northern Portugal
• Dairy cattle farms in N Portugal:
  • Mild climate, moist (>1100 mm precipitation)
  • Maize and grass silage
  • Imported concentrates
  • Year-round housing

Objective
To use the Farm-AC modelling approach to quantify the magnitude of the nitrogen losses and investigate measures to reduce them.

Introduction

• Intensive dairy farm case study from the North was selected.
• The FarmAC model (www.farmac.dk) was used to estimate C and N flows on the case study in the Northern Portugal.
• This type of farm is quite common in the North of the country and the extent to which N losses can be reduced, was evaluated by trying different changes in management.

Methods

Farm-AC model (http://www.farmac.dk/)

• Intensive dairy cattle farm:
  • 6.5 LU ha⁻¹, dairy cows + followers
  • 7800 litres ECM yr⁻¹
  • Manure applied =755 kg N ha⁻¹ yr⁻¹
  • Fertiliser applied =100 kg N ha⁻¹ yr⁻¹
  • Potential DM yield = 35 Mg ha⁻¹ yr⁻¹

Results

• Intensive dairy cattle farm
  • DM production = 29 Mg ha⁻¹ yr⁻¹
  • Milk production = 34 Mg ha⁻¹ yr⁻¹
  • N losses:
    • NH₃: 93 kg N ha⁻¹ yr⁻¹
    • N₂O: 16 kg N ha⁻¹ yr⁻¹
    • NO₃: 70 + 277 kg N ha⁻¹ yr⁻¹ (344 mg NO₃⁻ litre⁻¹)

How to reduce N losses:
1. Remove N fertiliser
2. Reduce stock density to achieve 50 mg NO₃⁻ litre⁻¹
   • Also reduce concentrate feed import

1. Removing N fertiliser:
   • No change in production
   • NH₃: 90 kg N ha⁻¹ yr⁻¹
   • N₂O: 15 kg N ha⁻¹ yr⁻¹
   • NO₃⁻: 277 kg N ha⁻¹ yr⁻¹ (258 mg NO₃⁻ litre⁻¹)

2. Reduce stock density:
   • LU ha⁻¹ = -42%
   • DM production = -5%
   • Milk production = -50%
   • NH₃: 54 kg N ha⁻¹ yr⁻¹
   • N₂O: 10 kg N ha⁻¹ yr⁻¹
   • NO₃⁻: 52 kg N ha⁻¹ yr⁻¹ (48 mg NO₃⁻ litre⁻¹)

Conclusions

✓ Nitrate leaching problems in N Portugal may partly be because the fertilizer value of manure on intensive dairy farms appears to be undervalued.
✓ Removing fertilizer N did not affect production as the system is saturated with N.
✓ Removing all fertilizer N reduced nitrate concentration in drainage but compliance with the Nitrates Directive requires substantial reduction in stock density

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