Developing tools for land users and policy makers to assess the impacts of land use change and intensification – a New Zealand perspective

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Agricultural land use in New Zealand

- Agriculture, forestry & horticulture
  - 65% of export value – NZ$23 B
  - >20% of GDP
  - 50% of greenhouse gas emissions
Changes in Land-Use Management

Fertiliser

Irrigation
Changes in Land-Use Management

- **Dairying - 1990 to 2007**
  - National herd increased by ~20% to 5.2 M
  - In Canterbury – dairy area increased by 67% and cow numbers increased by 90%
  - Increased fertiliser N use & irrigation use

- **Strong economic production drivers**
  - 75% increase in milk solids returns

- **Environmentally sustainable?**
Water quality policy & management questions

- What types of land uses, and
- How intensive can these land uses be without exceeding a groundwater envir. limits?
- How might land be managed to remain profitable and within envir. limits?

i.e. How many dairy farms, potato farms, onion fields, market gardens, sheep farms… should be allowed on a “catchment”? 
IRAP – Integrated Research for Aquifer Protection
IRAP Policy tools

Predict effect of land use on NO$_3$ leaching to GW

Predict effect on GW NO$_3$ conc.
Policy Question - What happens to groundwater NO₃ concentrations if a land use changes from sheep to dairy farming?
LUCI Framework Model - simulating effects of a land use on NO$_3$ leaching...
LFM, a model of a field that can….

- Start anytime
- Run for as long as you like
- Handle any sequence of crops and or pasture
- Account for the changing C N balance of the soil – including animal offtake and inputs
- Balance the detail of plant processes with soil processes
- Predict the leakage
- Fit into a model at larger scale
Cropping rotation simulations

F-M-F Deep Soil

Accumulated leached NO3

F-M-F Shallow Soil

Accumulated leached NO3
LFM Model applications

- Provide input data for AquiferSim
- Other…
  - Examining policy options to reduce $N_2O$ emissions & NO$_3$ leaching
  - NO$_3$ leaching downstream of proposed irrigation scheme
  - Irrigation water allocation
Policy application example

- What is the likely effectiveness of two policy options to reduce N$_2$O emissions and NO$_3$ leaching?
  - Charge on N fertiliser
  - Incentive to use a nitrification inhibitor?

- Approach:
  - Simulate NO$_3$ leaching at lower rates of fert. N
  - 2 Crops
    - Autumn sown wheat
    - Spring sown potatoes
  - 4 regions
  - 10 years of climate data
Model applications – crop, water & nutrient management on farm

- Crop models used in DSS “crop calculators”
  - Sirius wheat, Potato & Brassica calculators, AmaizeN
  - Aid management of irrigation & N fertiliser to:
    - Improve crop yield & quality
    - Optimise use of soil mineral N
    - Minimise nitrate leaching losses
    - High level of uptake…
      - Sirius wheat calc influences 60% of wheat crop
      - All growers for a major potato processor use Potato calculator
- Calibrating nutrient budget tool for range of crops
Thank you