Neural Networks for Predicting Nitrate-Nitrogen in Drainage Water

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Background

As nitrate is considered the main indicator of groundwater contamination from feedlot manure or nitrogen fertilizer, it is imperative to monitor the nitrate-nitrogen concentration in shallow groundwater and drain outflows. Nitrate-nitrogen losses in tile effluent also represent a loss of valuable nitrogen fertilizer and a reduction in production efficiency. The application of neural network offers a potential new tool for accurately simulating the complex nitrogen dynamics in artificially drained soils; thereby, help in tracking nitrate movement associated with crop and animal production systems.

Objectives

- To train, test and optimize a fast back-propagation neural network for predicting tile flows and nitrate-nitrogen concentrations in tile effluent using existing field data collected over a 40-month period.
- To train, test and validate a radial basis function neural network for predicting the two parameters using the same available experimental data.
- To compare the results of the two neural network models with the predictions of the commonly used DRAINMOD-N model.

Results

- Two artificial neural network models were developed for simulation of subsurface drain outflow and nitrate-nitrogen concentration in drain effluent from field plots subjected to no-tillage and conventional tillage treatments.
- The optimum configuration for the fast back-propagation neural network comprised of a learning rate of 0.02 and 20 neurons in the hidden layer.
- The best architecture for the radial basis function (RBF) neural network was obtained with a tolerance of 20, receptive field of 15 and 547 neurons in the hidden layer.
- A comparison of the results from the two models indicates that the radial basis function network may be used for predicting drain outflow and nitrate-nitrogen concentration on both daily and monthly basis. The fast back-propagation network appears to be suitable for simulation of the two output parameters only on monthly basis.
- The deterministic model, DRAINMOD-N, requires extremely large data sets and extensive calibration & testing.

Take Home Messages

- A comparison of the results from the two artificial neural network models indicates that the radial basis neural network is superior to the fast back-propagation network model in predicting the concentration of nitrate-nitrogen in drain outflow due to the application of manure and/or fertilizer. The RBF network can be used for assessing the impact of nitrogen application, either from animal sources or from fertilizers, on groundwater quality.

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