Title: **Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal-Nitrogen Transformations (Study No. 26)**

Investigators:

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Objectives: This project was undertaken to determine the nitrogen transformations in wastewater from two dairy products industries as it percolated from the furrows to the groundwater. Ridge and furrow land treatment effectiveness was evaluated under various soil and loading conditions. Operation, maintenance and accuracy of the monitoring equipment used were also studied.

Background/Need: A ridge and furrow land treatment system consists of a series of ditches which allow for the distribution, infiltration and treatment of wastewater. Two ridge and furrow systems were studied: a cheese factory in Brodhead, Wisconsin which discharged an average of 39,500 gallons per day (gpd) of wastewater, and a creamery in Mindoro, Wisconsin which discharged an average of 14,000 gpd of processing wastewater.

Methods: Groundwater monitoring wells and lysimeters were installed and soil grab samples taken during the initial soils borings. Flow composited influent wastewater samples were collected monthly. Furrow samples were taken during intensive sampling periods at Brodhead in October and Mindoro in November of 1984. Samples were also collected routinely from the wells and lysimeters.

Wastewater, furrow, lysimeter, groundwater and stream samples were analyzed for biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), chlorides (Cl^-), total Kjeldahl nitrogen (TKN), ammonium nitrogen (NH_3-N), nitrate and nitrite nitrogen (NO_3-N+NO_2-N) and pH. Soil and plant samples were also analyzed. Other monitoring included observation of load/rest cycles, reading monthly groundwater and surface water elevations, taking monthly 30-day average wastewater flow readings, cutting periodic grass samples during the growing season to determine nitrogen uptake and performance of infiltration studies to determine unsaturated zone flow rates.

Results: Wastewater nitrogen loss was attributed to denitrification and leaching at both sites. Plant uptake was also a factor for Mindoro. Both Brodhead and Mindoro had average BOD_5 loading rates over the 100 lb/acre/day Department of Natural Resources limit. COD was greatly reduced as wastewater infiltrated into the groundwater. The nitrogen content of the

wastewater at both sites was mainly in the organic form. It mineralized to ammonium nitrogen in the settled solids which accumulated in the furrows. The ammonium-nitrogen was oxidized to nitrate-nitrogen as it infiltrated through the unsaturated zone.

Wastewater treatment and disposal in a ridge and furrow system was influenced by wastewater distribution and infiltration, load/rest cycling, winter operation and annual cover crop burning. Grass overgrowth and leaky header gates caused poor wastewater distribution at Mindoro, though this was not a problem at Brodhead. The Brodhead system experienced decreased nitrogen concentrations in the groundwater and improved soil aeration and infiltration due to a short load/rest cycle. Ponding resulted in part from a longer load/rest cycle at the Mindoro system. Annual grass burning enabled a modest nitrogen loss at both locations. Winter operation proceeded adequately at both sites, though Brodhead fared better during subzero temperatures.

Downgradient groundwater concentrations of contaminants were impacted to a greater extent at Brodhead than Mindoro. Nitrogen and COD reductions in the unsaturated zone were similar at Brodhead and Mindoro, though a greater percentage were removed at Brodhead than Mindoro. This difference was attributed to sandy soils at Brodhead which allowed for faster unsaturated travel times than silty loam soils at Mindoro.

Conclusions:

Investigators concluded that nitrogen losses around the unsaturated zone were attributable to denitrification at both sites. BOD_5 tests indicate that wastewater loading did not produce an oxygen demand high enough to inhibit denitrification. Nitrogen and COD reductions were dependent on infiltrative capacities. The nitrogen in wastewater applied at both sites was mainly in the organic nitrogen form, which ammonified and eventually diffused into the overlying furrow wastewater. Dissolved ammonium was the primary form of nitrogen in the wastewater applied to the furrows. Surface water remained unaffected from the operation of the ridge and furrow systems at both sites.

Recommendations/ Implications:

Further research is suggested to better determine the impact of loading changes on groundwater quality and to better quantify unsaturated flow times by the installation of tensiometers. Nitrogen loading rates should be met by dischargers to reduce or maintain groundwater nitrogen concentrations. Solids accumulation in the furrows at Brodhead should be reduced with wastewater pretreatment. Chloride concentrations in the Brodhead wastewater should be reduced by brine removal in the plant or prior removal. Annual spring grass burning is suggested for all ridge and furrow systems where feasible. A downgradient well nest should be installed at Mindoro to better define the movement of contaminants off-site. Also suggested is an improved lysimetry method to obtain a more instantaneous sample and allow for winter sampling.

Availability of Report: This report is available for viewing and loan at:

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