

# Nitrogen Cycling and Losses for Outdoor Wintering of Dairy Cows

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## Introduction

The outdoor winter-feeding and housing of livestock is a practice used by some dairy producers in combination with summer grazing to keep production costs low. While these low cost production systems can help sustain a diversified dairy industry in Minnesota, attention needs to be given to water pollution risks associated with wintering practices. Low cost management recommendations that protect water quality are needed.

A research and demonstration project has been established at the University of Minnesota, West Central Research and Outreach Center to evaluate both livestock production and water quality issues surrounding outdoor wintering of lactating dairy cows. The project involves a 100 cow dairy herd that is rotationally grazed in summer and fed outdoors in winter. Winter-housing is done where cows are protected from wind on straw bedding in a site that is managed as a calf pasture in the summer. The bedding material is piled in the spring and land applied in the fall. The objectives of this study were to: 1) characterize nitrogen (N) cycling during outdoor wintering of dairy cows, and 2) assess the risk of water degradation from N losses.

## Materials and Methods

Thirty mature dairy cows were wintered on a bedded pack of wheat straw from December 12, 2001 to April 10, 2002 in a 1.0 acre lot at the West Central Research and Outreach Center in Morris, MN. During this period, detailed records were kept of all N inputs including total mixed ration feed (TMR), hay, and wheat straw bedding material. Nitrogen outputs in milk were determined from daily milk production records and measured milk composition. Manure from the straw bedded pack was stockpiled in the spring in the wintering lot, left to passively compost, and was removed for land application in the fall. Mass of manure removed and manure N composition was used to determine N removal. Nitrogen losses to tile drainage water were measured in an automated system throughout a one year period. Nitrogen losses to surface runoff were estimated using a series of rainfall simulations. Nitrogen accumulation in the wintering lot soil was determined as the difference in soil N composition before and after wintering determined with a detailed grid sampling approach. Gaseous N losses were determined by difference of N inputs and all measured N outputs.

## Results

Nitrogen inputs to the wintering lot were nearly 4400 lb, mostly from feed (Fig. 1). This is equivalent to 1.2 lb N cow<sup>-1</sup> day<sup>-1</sup>. Land applied manure and milk production accounted for 32 and 20 % of N inputs, respectively (Fig. 1). Approximately 16 % of N inputs accumulated in the soil, mostly in the manure storage and feeding areas. Much of this N has the potential to be taken up by vegetation if the wintering site is successfully vegetated during the summer period. Little N accumulation was observed in the soil directly beneath the area of the winter bedded pack, suggesting that little leaching occurred in winter. On the contrary, accumulation of soil N occurred in the manure storage and feeding areas. Nitrogen losses in runoff and drainage were

less than one percent of N inputs, but concentrations of N were high. On the scale of large watersheds (i.e. Minnesota River Basin), this type of livestock feeding may not be a large source of N pollution. However, wintering areas may be an important source of N in waters at a local scale. This emphasizes the importance of careful siting practices, especially for manure storage. Focus should be placed on improved management practices for the manure storage. Gaseous N losses from the wintering system were 32 % of N inputs. These gaseous N losses may pose the largest environmental risk from outdoor wintering.

### Conclusions

A research and educational facility for evaluation of outdoor wintering of dairy cows has been successfully established. In addition to the N cycling research, production and economics of the system are being evaluated. Cow health in the system has been excellent. The use of a winter bedded pack resulted in no measured accumulation of N in the soil, suggesting that nutrients did not leach through the bedding into the soil. Nitrogen did accumulate in soils beneath the summer manure storage area. Nitrogen losses to surface water represented less than 1% of the total N inputs to the system, but concentrations of N in leaching and runoff were high. This emphasizes the importance of careful siting practices, especially for manure storage. In addition, this study can be used to evaluate the potential for low cost practices to treat runoff water, such as vegetated filters or constructed wetlands. Gaseous N losses may pose the largest environmental risk from outdoor wintering and an associated summer manure pile.

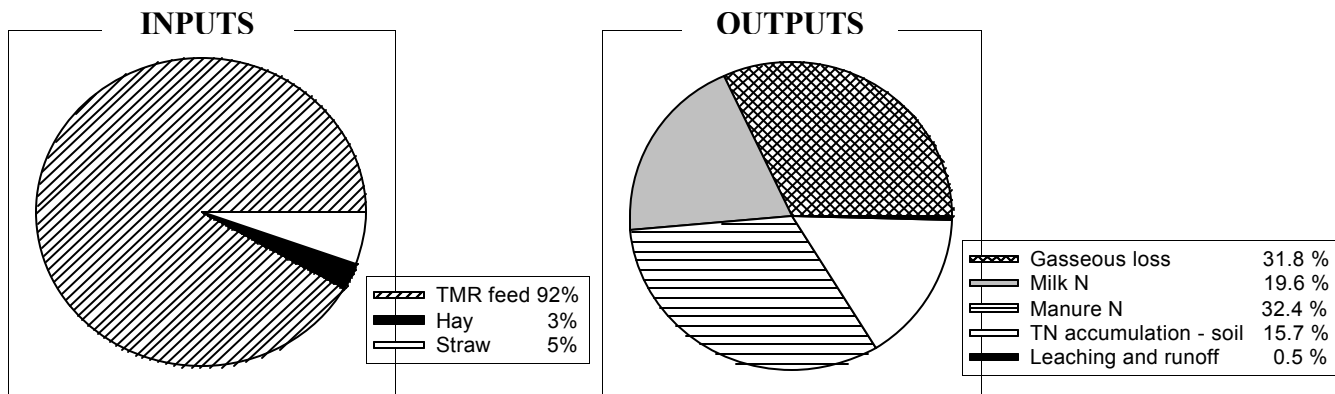


Figure 1. Controlled nitrogen (N) inputs (left) to the lot during wintering period 12/2001 to 04/2002 and outputs (right) as a percent of total N inputs. Total mass of N input was 4400 lb.