Nitrate Leaching in Manured Alfalfa and the Alfalfa-Corn Rotation.

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Many dairy farms in Massachusetts and the Northeast have a high ratio of livestock per acre of cropland. High density confinement of animals offers economies of scale but often results in problems for manure disposal. Thus, nitrogen availability on dairy farms may exceed the amount required for corn production. Many farmers also apply commercial fertilizer to corn fields in addition to manure and this may further add to the problem of nutrient excesses and potential contamination of ground and surface waters.

Alfalfa-corn is the preferred cropping rotation on dairy farms in Northeast. If manure application to alfalfa is widely adopted to avoid excess applications to corn fields, it is essential to determine the additive effects on corn and on groundwater quality of the nitrogen accumulated during the period of alfalfa plus the residual nitrogen from additional manure applications.

In our ground water quality studies started in 1990, in south Deerfield and Sunderland, we compared applications of low (100 lb N ac^{-1}) and high (300 lb N ac^{-1}) rates of manure and synthetic nitrogen fertilizer (NH_4NO_3) with a check (no N fertilizer). Water samples were collected through porous cup suction samplers placed at 1, 2, 3 and 4 foot depths. Application of manure at the low rate resulted in significantly lower concentrations of nitrate-N in water samples at both sites compared to high and low fertilizer. Concentrations of nitrate-N in water and soil samples from low manure plots were lower or similar to those taken from check plots. At the Sunderland site, where soils were coarser textured, high manured plots had a greater frequency of nitrate-N exceeding the 10 mg L^{-1} drinking water standard compared to check plots and low manured plots.

Crops succeeding legumes usually require less nitrogen fertilizer. It is important to observe the potential for nitrate-N leaching in the alfalfa-corn rotation, particularly after alfalfa is incorporated and before corn has developed an extensive root system for nitrogen uptake. It is important to know the amounts of nitrogen accumulated during alfalfa growth and added into the system from incorporation of alfalfa, and from previous application of manure to alfalfa, when rotating to corn.

In these studies the harvest management followed was a 3 cut system. After 3 years of manure application at low rate (20 tons/acre liquid manure) and high rate (60 tons/acre liquid manure), there was no significant difference in forage yield in low manure plots compared to control (no nitrogen or manure) plots. This is the most important finding for the dairy farmers point of view as they may be concerned with spreading of manure on alfalfa fields.

Water samples collected through porous cup samplers showed a varied concentrations of nitrates among the treatments. Percentage of samples (Figure 1) showing the concentrations above 10 mg L^{-1} (EPA maximum permissible limit) in the third year of

manure application to alfalfa were highest in the treatment receiving manure at high rate (60 tons/acre). Water samples collected at 2 ft depth had the highest number above 10 mg L^{-1} level. This could be the cumulative result of three years of manure application to alfalfa. In the previous two years the high fertilizer treatment had exceeded the high manure treatment, but in this third year this treatment was not included.

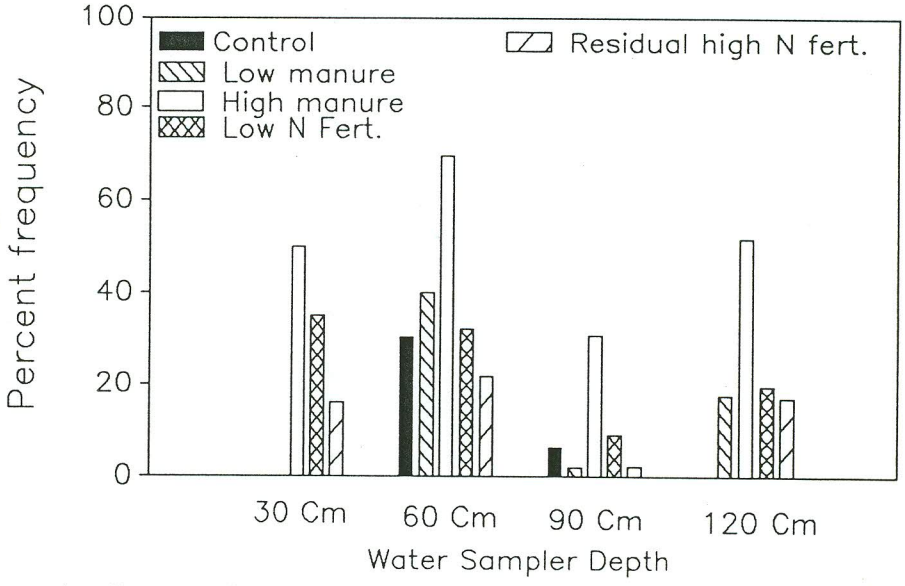

Figure 1. Percent frequency of water samples showing concentrations above 10 mg NO_3-N L^{-1} under alfalfa during 1992 at South Deerfield.

When alfalfa was rotated to corn after two years of manure application at the Sunderland site, there was no significant yield differences among the treatments (Fig. 2). Application of nitrogen fertilizer or manure at low rate did not increase corn yield. Incorporation of alfalfa before corn planting had provided sufficient nutrients for a satisfactory corn yield. Additional application of fertilizer or manure to corn in this rotation would thus have resulted in wastage of resources, more expenditure, less profits, and more possibility for ground water pollution.

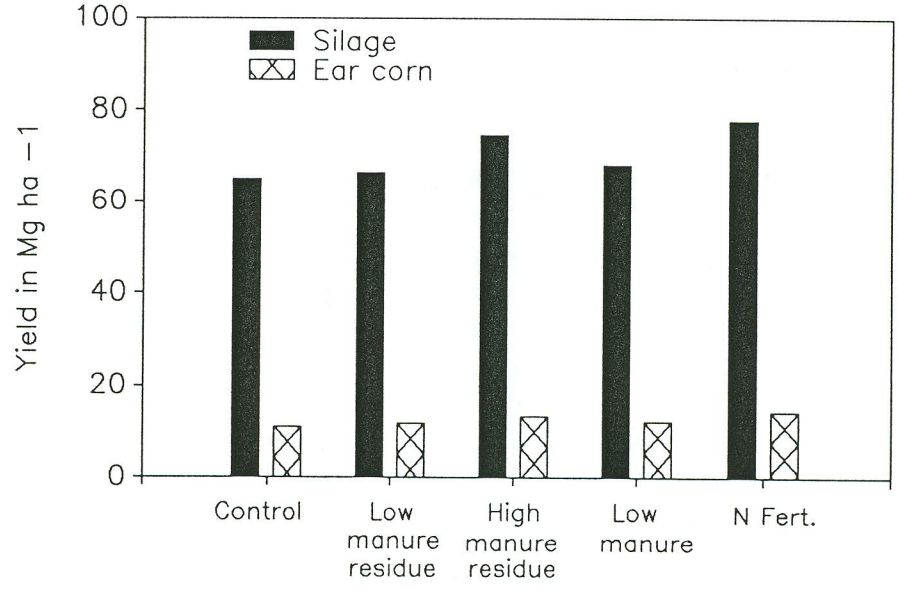

Figure 2. Silage and Ear corn yields during 1992 at sunderland site.

Water samples collected in corn succeeding two years of alfalfa in the rotation had a high percentage of samples above 10 mg NO_3-N L^{-1} including check plots (Fig. 3.). Additional application of nitrogen fertilizer or manure resulted in increased number of samples going above EPA limits. No nitrogen fertilizers or manure applications are required for corn in the first year succeeding a reasonable alfalfa stand.

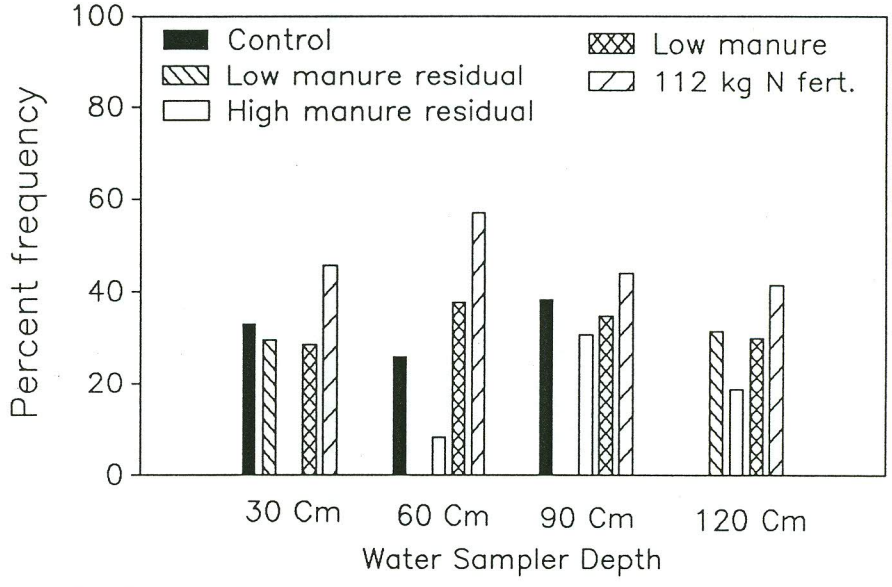

Figure 3. Percent frequency of water samples showing concentrations above 10 mg NO_3-N L^{-1} under corn during 1992 at Sunderland site.

In summary, application of manure to alfalfa at low rate for the third consecutive year has neither decreased forage yield nor increased nitrate nitrogen concentrations in water samples compared to check plots. There was no significant differences in corn yield succeeding two years of alfalfa and additional application of nitrogen fertilizer or manure resulted in increased percentage of water samples showing above 10 mg NO_3-N L^{-1}. A good nutrient management plan for alfalfa-corn rotation must include credits from crop residues, manure residues, and longevity of previous alfalfa stand. A good nutrient management plan will also increase profits for dairy farms and reduces nitrate pollution of ground and surface waters.