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ONTARIO FEDERATION OF AGRICULTURE

Assessing the nitrogen losses from late season application of liquid dairy manure

INTERIM REPORT

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ASSESSING THE NITROGEN LOSSES FROM FALL APPLICATION OF LIQUID DAIRY MANURE APPLIED TO CORN, SOYA AND FORAGE FIELDS

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EXECUTIVE SUMMARY

The Ontario Federation of Agriculture has sponsored a project to assess the effects of late fall application of liquid manure on tile drainage and surface runoff. Late fall application of manure could potentially be used as an important manure management tool if proven to be non-detrimental to the environment. It is more compatible with the production of certain crops (such as corn) which are harvested late in the year; it would allow tankers to get onto the fields when the ground is firm enough to carry the weight; and it may also provide the added benefit of having the manure nutrients readily available for uptake by the plant in the spring.

Thirteen independently drained, hydraulically isolated plots were installed on the Alfred College campus for the purpose of testing the effects of manure application regimes on nitrogen concentrations in tile drainage and surface runoff. Surface and subsurface drains from each plot lead into a monitoring station equipped with tipping buckets (for measuring flow) connected to a data logger which also serves as a controller for peristaltic pumps which are used for sample collection.

To test late season application, manure was spread on ten plots on December 23 and three plots were left as controls. Samples will be analyzed over the winter and spring of 1997. In the spring, three different crops will be planted on four plots each. Funding is currently being solicited from a number of sources to extend the sampling regime for at least another year so that the effects of crop uptake can be observed.

This project responds to the Ontario Dairy Research and Services Committee research priority recommendation 7: To support research to assess manure handling systems ... to minimize environmental impact. The idea for the project came from the industry (OFA and OSCIA).

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OBJECTIVES

- 1) To determine if manure can be safely applied during the late autumn period so that crops obtain the maximum benefit from the manure while producers avoid spreading during the busier spring season;
- 2) To document the proper procedures to follow when applying manure late in the fall;
- 3) To monitor nitrogen losses of late fall application of manure.

RATIONALE: PROJECT BENEFITS

The Ontario Ministry of Agriculture, Food & Rural Affairs currently recommends against spreading manure in late fall due to fears of excessive nitrogen concentrations in runoff. However, many producers would prefer to have the option of spreading manure during this time of year. Late fall manure application presents several practical advantages:

- 1) One less operation to perform in the spring;
- 2) Easier to get onto the fields after the ground begins to freeze;
- 3) May reduce odours;
- 4) More compatible with certain cropping systems (i.e. corn);
- 5) Reduced compaction;
- 6) Custom applicators may be more readily available than at other times;
- 7) In some circumstances, it may eliminate the necessity of enlarging the existing storage facility or building a new one.

There are also scientific arguments for spreading during the late fall rather than immediately after harvest. If manure is spread after the growing season but before the onset of colder weather, i.e. in early autumn, bacteria would convert organic nitrogen into ammonium by *ammonification* and ammonium into nitrate by *nitrification*. Bacterial activity is expected to slow down with the onset of colder weather in late autumn so that nitrification should be greatly reduced. Since nitrogen is most mobile in groundwater when in the form of nitrate, spreading manure in late autumn, when the rate of nitrification is lower, should reduce nitrogen losses in drainage water. During the spring thaw, nitrogen should be converted into nitrate and be immediately available for plant uptake. In short, spreading manure immediately following the summer growing season results in nitrates being formed at a time when plant uptake is minimal while spreading during the colder late autumn period delays nitrate formation until spring, when plants are in most need of nutrients.

EXPERIMENTAL DESIGN AND PROCEDURE

Setup

The experimental set-up consists of thirteen 100 m x 15 m plots. Each of these plots is independently drained and a "hickenbottom" was installed in each to collect surface runoff. Polyethylene curtains, installed to a depth of 4 feet, divide groundwater flow between plots. Small soil berms prevent surface water from crossing from plot to plot. The surface and tile drains all flow into a cabin which houses the monitoring equipment (see figure 1).

The monitoring station is a partially buried 8.5 ft x 15 ft cabin of pressure treated lumber sitting on a two foot deep bed of 3/4 inch washed crushed stone. Twenty six pipes lead into the station: a subsurface drain and a surface drain for each plot. Flow rates are measured using "tipping buckets" (2.6 L/tip) and recorded with a data logger. The tipping buckets dump into the crushed stone (there is no floor) and the water is evacuated by two submersible pumps into a drainage ditch.

Composite surface water samples are taken by pumping 50 ml every 50 tips with peristaltic pumps (tubing pumps) connected to small funnels installed below the pipes. The peristaltic pumps are triggered by the data logger/controller. Composite samples of subsurface water is collected in bottles placed below the outlet of the drainage tiles. These bottles have small openings so that a few drops are collected each time the buckets tip.

Manure was applied on ten plots and three plots were left as controls. Samples are being collected and analyzed for total nitrogen. Twenty to thirty samples will be collected from each pipe throughout the winter and spring of 1997. In the spring, four plots will be planted with corn, four with soya and four with a forage crop.

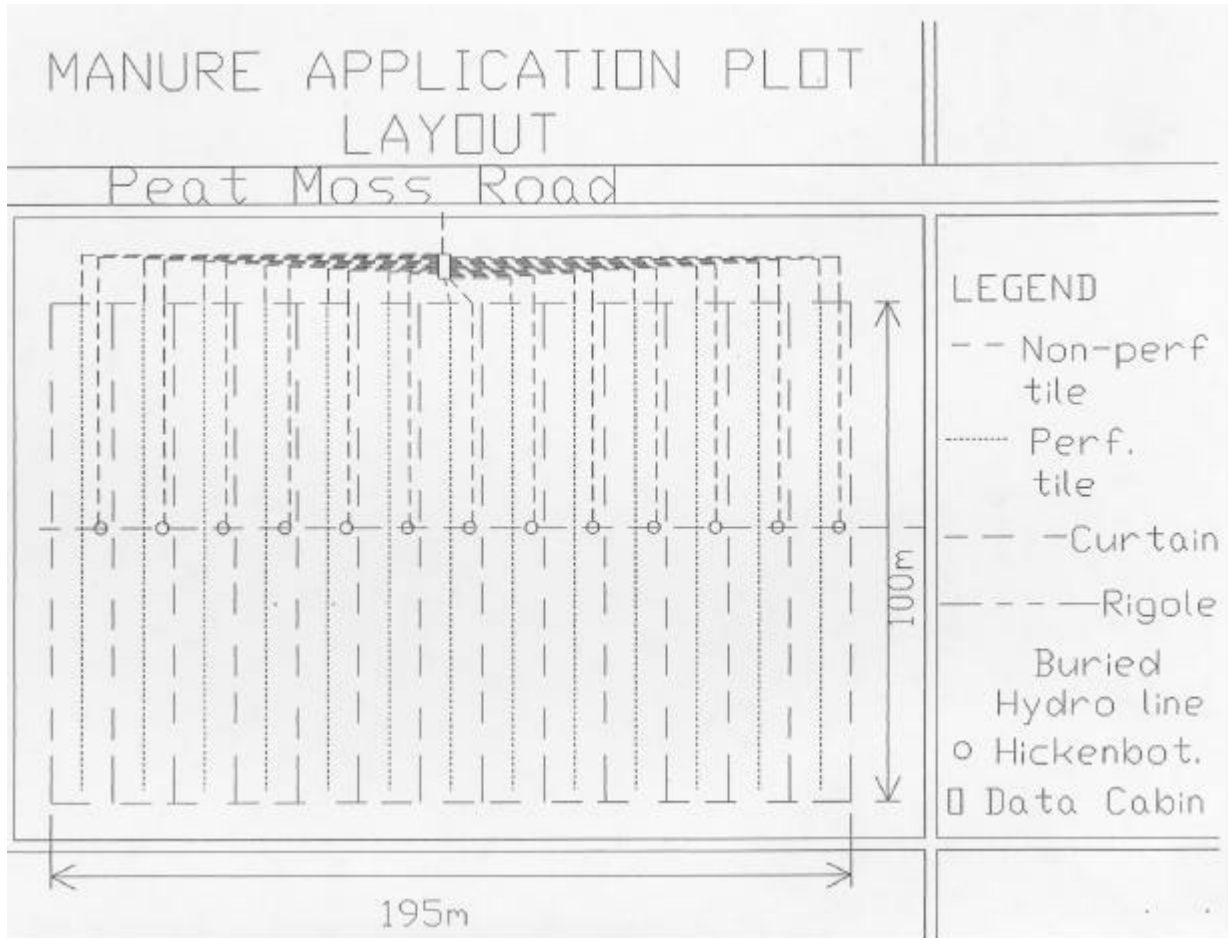
Construction

Since local drainage contractors were in great demand in Eastern Ontario during the autumn of 1996, it was not possible to begin construction until November 2nd.

Drainage works

The drainage tiles were installed by a local drainage contractor with a trenchless plough. The first step was to excavate a trench for the "end runs" of the drainage tiles as well as a hole for the monitoring station. The tiles (4 inches) were ploughed in 100 m runs perpendicular to the end trench. Non-perforated tiles (4 inches) were ploughed in 75 m runs and connected to hickenbottoms (installed in an existing shallow swale). The end-runs, non perforated tiles (4 inches), were laid by hand in the trench, leading from the free end of each subsurface and surface drain to the monitoring station excavation. A foot of sand was placed above the end-run tiles to prevent them from breaking and the trench was backfilled (up to the monitoring station excavation) with native soil.

Figure 1. Experimental Setup



Monitoring Station

The monitoring station, an 8.5' x 15' cabin, was constructed in panels of pressure treated lumber and plywood and delivered to the site. It was assembled on top of a two foot layer of crushed stone in the excavation. Holes were cut into the side of the cabin and the end-tiles were pulled through. The station was backfilled with sand. Two submersible pumps (in case one breaks down) were installed in a sump hole in the corner of the cabin. These discharge into the drainage ditch alongside the road behind the test plots.

Curtains

The original plan was to install the plastic ground water curtains with a chain trencher before the drainage tiles were installed. However, because the soil was still wet, the trenches kept filling back in. It was therefore necessary to wait until the drainage work was complete before installing the curtains. After the drainage works were complete, the ground was frozen at the construction site. However, the month of December 1996 was unseasonably warm in Eastern Ontario. A thaw began the week of December 2nd which allowed the continuation of work on the site.

Since the soil was still wet after the thaw, it was decided to install the curtains with backhoes and a bulldozer rather than making another attempt with the chain trencher. Two backhoes excavated trenches while the site inspector placed the curtains. The trenches were backfilled by the dozer. The dozer was then used to level out the entire site.

Ploughing

The field was "disked" then ploughed. A backblade was used to form the berms above the curtains between each plot.

Manure Spreading

It was not possible to spread manure until December 23rd because the custom application contractor felt that the field was too soft (it was not yet frozen). Four loads of 5625 gallons were spread approximately evenly over ten plots.

PROJECT SCHEDULE

Table 1: Project Schedule

| | Action | Completion Date | Status |
|-----|--|------------------------|---------------|
| 1. | Searched for relevant literature at NRC library. | | on-going |
| 2. | Visited 3 farms about performing trials but decided it was not feasible because there would be no control over ground water flow and monitoring would not be accurate. | Oct. 14, '97 | complete |
| 3. | Chose appropriate site on College campus and performed initial survey. | Oct. 18, '97 | complete |
| 4. | Experimental set-up and protocol defined. | Nov. 1, '97 | complete |
| 5. | "Tipping buckets" (to measure flow rates) manufactured. | | complete |
| 6. | Drainage works installed. | Nov. 15, '96 | complete |
| 7. | Built monitoring station. | Nov 16.; '96 | complete |
| 8. | Programmed data logger. | Nov 19, '96 | complete |
| 9. | Sent update letter to OFA. | Nov. 20, 96 | complete |
| 10. | Installed groundwater flow control curtains. | Dec. 5, '96 | complete |
| 11. | Ploughed field & constructed berms between plots. | Dec.6, '96 | complete |
| 12. | Alfred College researcher (Ian Malcolm) met with OFA Farm Policy Researcher (David Armitage) in Toronto to discuss project. | Dec. 11, '96 | complete |
| 13. | Installed monitoring equipment (tipping buckets, data logger & pumps. | Dec. 20, '96 | complete |
| 14. | Spread manure. | Dec. 23, '96 | complete |
| 15. | Began sampling. | Dec. 23, '96 | complete |
| 16. | Update report sent to OFA. | Jan. 13, '97 | complete |
| 17. | Proposals submitted to U of Guelph, Canadapt, etc., to continue for two more years. | Feb. 1. '97 | on-going |
| 18. | Literature review written. | Feb. 28, '97 | on-going |
| 19. | Data analyzed. | March 21, '97 | planning |
| 20. | Draft report submitted to OFA | March 28, '97 | planning |
| 21. | Final report submitted to OFA | April 25, '97 | planning |

BUDGET

The total of Alfred College's first invoice, billed on November 20, 1996 was \$30 401.81. Invoices for construction and monitoring materials were included. A second Alfred College invoice, for the balance of the total project cost, \$13 598.19, will be billed February 1st to cover costs to be incurred before March 31, 1997. Proposals will be submitted to extend the study period by two years.

OBSERVATIONS AND CONCLUSIONS

Some subsurface drainage samples taken immediately after spreading were yellow in colour. Although the results of the sample analyses are not yet available, it is clear that liquid manure found its way into the tile drains. This occurred because the tile drains were just installed the previous month and the soil has not yet had time to settle and seal off any cracks or openings.

RECOMMENDATIONS

The only recommendation that can be made at this time is to avoid spreading liquid manure on newly tiled fields.

ACKNOWLEDGEMENTS

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