



Introduction

Field application of hog manure as fertilizer could be an environmentally sustainable solution to a waste disposal problem. However, with increasingly large amounts of manure produced in a single location and prohibitively high transportation costs, there is concern that manure applications close to hog operations may exceed environmentally sustainable rates. Nutrients applied in excess of crop requirements can accumulate in soil, be transported in runoff to surface waters or leach through the soil posing a threat to groundwater.

This study is designed to assess the impact of hog manure application on water and soil quality.



Fig. 1. Low disturbance Injection System

- Landscape-based study using field-scale equipment and plots
- Long-term research (initially 6 yrs funding) at Perdue and Elstow, SK. To date manure has only been applied at the Perdue site.
- Monitoring of surface and groundwater quality and quantity
- Monitoring of soil quality (de Gooijer & Schoenau)

Study Site

The study site is located in the steeply rolling topography of the Bear Hills near Perdue, SK.

- Soils at the site are clay loam-textured Dark Brown Chernozems of the Keppel Association
- Organic C content ranges from 1.4 to 2.7%
- Slopes range up to 20 %

Three externally-draining basins, ranging in area from 4 to 7 ha, were selected to receive the manure study treatments. The basins were monitored for one year prior to manure application to collect baseline data for the site.



Fig. 2. Site at Perdue after manure application

Manure Application

- Manure was injected by a commercial applicator using low disturbance openers.
- The first manure application was made in the fall of 1999 and subsequent applications will be made once every 2 years.
- Manure application rates of 7,000 and 10,000 gal/ac were compared to an inorganically fertilized control.
- In 1999, the N rates were 220 and 315 kgN/ha while the P content of the manure was more variable and gave average rates of 60 and 90 kgP/ha.

Monitoring & Analysis

- V-notch weirs are installed on the drainage basin outflows in the fall.
- Surface soil moisture content and available nutrients are measured each fall.
- Snow surveys are done prior to snowmelt in each year. Snow samples are taken for nutrient analysis.
- Flows over the weirs during snowmelt are measured using flowmeters connected to automated water samplers.
- The samplers are programmed to take 1 sample every hour during runoff and these samples are composited to give a daily sample.
- Water and snow samples are analyzed for: Total and ortho P, NO₃ and NH₃, DOC (dissolved organic C), Cl and major ions, coliforms

Snow Accumulation & Runoff



Fig. 3. Partial snowcover during snowmelt (weir in background).

- Snow accumulation did not vary between treatments
- Most snow accumulated in 1999 (75 mm snow water equivalent), 50 mm accumulated in 2000 and only 33 mm were measured in 2001.
- Nutrient concentrations in the snowpack increased from 1999 to 2001.
- Runoff flow volumes reflected the snow accumulation. Flows were greatest in 1999 and in 2001 snowmelt runoff was only generated on 2 days.

Snowmelt Runoff Water Quality

Phosphorus

- During snowmelt in 2000 (after manure application), total and ortho P concentrations were greater in runoff from the basin that received 10,000 gal/ac hog manure than they had been in 1999 and were significantly greater than the control treatment.
- In 2001, P concentrations in runoff were greater than in the previous years and runoff from both manured plots contained more P than runoff from the control treatment.

Ammonia

- Ammonia concentrations in runoff from the manured treatments in 2000 were greater than background concentrations and concentrations in runoff from the control treatment.
- Concentrations of NH₃ measured in 2001 were lower than in the previous years and were lowest on the treatment that received 10,000 gal/ac hog manure in 1999.

Nitrate

- In 2000, NO₃ concentrations in runoff were lower than measured in 1999.
- The greatest NO₃ concentrations were measured in 2001 and concentrations in runoff from the manured treatments exceeded those in runoff from the control.

DOC, Ions and Coliforms

- There was slightly less DOC in runoff water in 2000 than in 1999.
- Concentrations of ions and coliform counts in runoff water did not vary significantly between treatments or years.

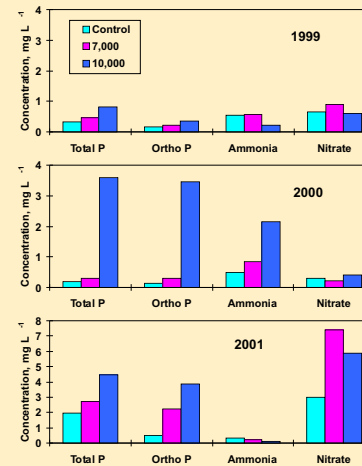


Figure 4. Snowmelt runoff water quality in 1999, 2000 and 2001.

Rainfall Simulation

- Rainfall was simulated in the fall of 1998 (before manure application) and in May of 2000 (7 months after manure application).
- Since, different rain sources and different rainfall simulators were used in 1998 and 2000, the data cannot be directly compared.
- During rainfall simulation prior to manure application, concentrations of P, NH₃, NO₃ and DOC were greatest in runoff from the control plot.
- During rainfall simulation after manure application, concentrations of P, NH₃, NO₃ and DOC were greater in runoff from the manured plots than the control plot.

Table 1. Nutrient and coliform concentrations in runoff from rainfall simulations 15 minutes after the start of runoff.

| Treatment | Total P | Ortho P | NH ₃ | NO ₃ | DOC | Cl ⁻ | Total Coliform |
|--------------------|---------|---------|-----------------|-----------------|------|-----------------|----------------|
| mg L ⁻¹ | | | | | | | |
| 1998 | | | | | | | |
| Control | 2.30 | 0.26 | 0.28 | 0.39 | 7.80 | 3.48 | 1700000 |
| 7,000 gal/ac | 1.21 | 0.03 | 0.21 | 0.22 | 5.34 | 4.03 | |
| 10,000 gal/ac | 1.85 | 0.03 | 0.13 | 0.09 | 5.15 | 3.21 | 26200 |
| Rain | 0.02 | 0.01 | 0.17 | 0.04 | 3.06 | 3.29 | >24000 |
| 2000 | | | | | | | |
| Control | 0.61 | 0.04 | 0.42 | 0.75 | 6.24 | 25.39 | 249 |
| 7,000 gal/ac | 1.98 | 0.94 | 1.76 | 5.16 | 9.21 | 29.94 | 17 |
| 10,000 gal/ac | 0.88 | 0.23 | 0.69 | 3.62 | 6.77 | 34.27 | 127 |
| Rain | 0.01 | 0.00 | 0.44 | 1.50 | 4.85 | 31.20 | <1 |

Conclusions

Preliminary results show

- Application of 10,000 gal/ac of hog manure in the fall of 1999 increased P and NH₃ concentrations in snowmelt runoff in the spring of 2000.
- P concentrations in runoff from the manured plots were still greater than the control during spring runoff in 2001.
- During rainfall simulation, nutrient concentrations were greater in runoff from the manured plots than the control plot.
- Hog manure application did not increase coliform counts in runoff water.

Acknowledgements

Thanks go to: SK ADF, SK Wheat Pool, SK Pork and AB Pork for funding; Erin Zoski, Denise Meier and Sherni Penh for assistance in the field; Bear Hills Pork Producers and Bill Turtle for their co-operation; and Jeff Schoenau and Henry de Gooijer our collaborators.