Nutrient Export in Run-Off from an In-Field Cattle Winterfeeding Site in East-Central Saskatchewan

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What is an in-field winter feeding system

- Bale grazing cattle on pasture land

Concerns with Runoff Water

- Jungnitsch (2008) documented increased nutrient returns with winterfeeding in-pasture system
- Nitrate-N is a health hazard at levels of 10 mg/L or higher
- Nitrogen and phosphorus increase potential for Eutrophication at levels exceeding (Glozier et al., 2006):
  - 0.280 mg/L for NO2-N/NO3-N
  - 0.119 mg/L for NH4-N
  - 1.1610 mg/ L for total nitrogen
  - 0.255 mg/L for total phosphorus

Objectives

- Determine the concentrations and export of nitrogen and phosphorus in snowmelt runoff water.
- To assess the amounts and forms of nitrogen and phosphorus in the soil surface layer

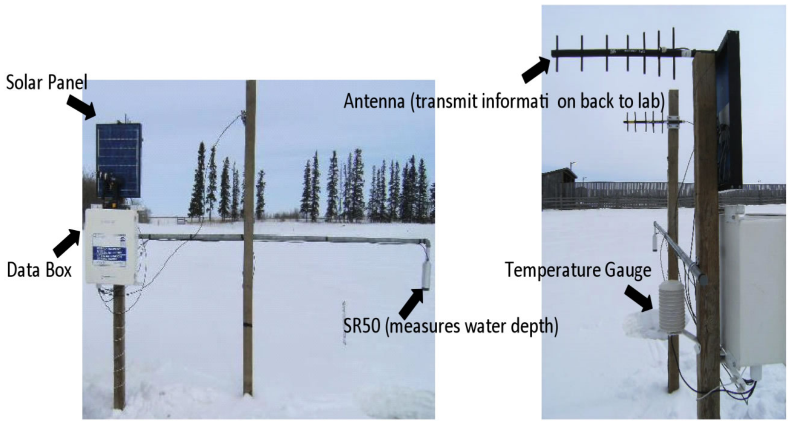
Hypothesis

- Concentrations and export of phosphorus and nitrogen in runoff water will be elevated in winter feeding sites

Site Set-up

- Divided pasture into control and winterfeeding with 4 basins in each
- Enclosed winterfeeding site with electric fence
- A range of 80 to 105 cows on winterfeeding site December 8th until March 6th

Data Logger Set-up



Sampling

1) Collect soil samples pre- and post-winter feeding.

Sampling

2) Collect water samples (runoff and ground water) from:
   - Control pasture and Winter feeding pasture watershed basins
   - Traditional dry-lot (Yard)

Analysis – Water Samples

- Filtered water samples were analyzed for:
  - Orthophosphate
  - Nitrate
  - Ammonium
  - Organic C
  - Total N
  - Total P
  - Counts of total colifroms
  - *Counts of Escherichia coli*

Analysis - Soil

- Soil samples analyzed for:
  - Extractable potassium, ammonium, nitrate and phosphorus
  - PRS supply rates of ammonium, nitrate and phosphate
  - Total N and P
  - Water extractable labile P
  - Bicarbonate inorganic and total P
  - Organic carbon
  - EC
  - pH

Orthophosphate-P in Runoff

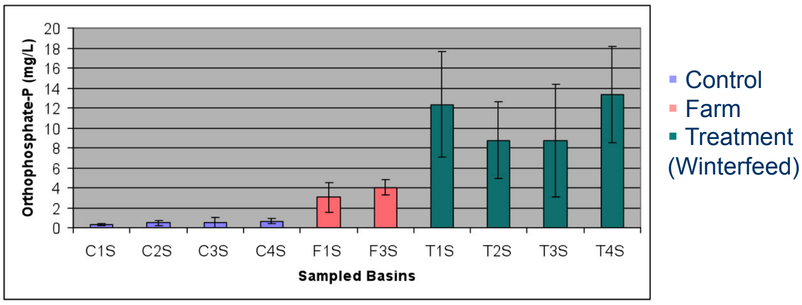
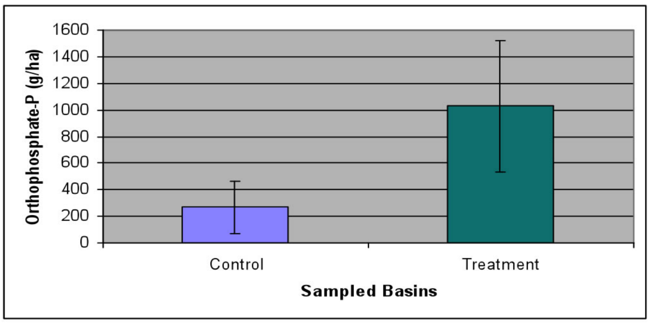


Figure 3.1 Average orthophosphate (SRP) concentrations from surface runoff water starting March 31 until April 19.

Significantly higher ($P<0.05$) ortho-P concentration in run-off from winterfeed watersheds compared to control.

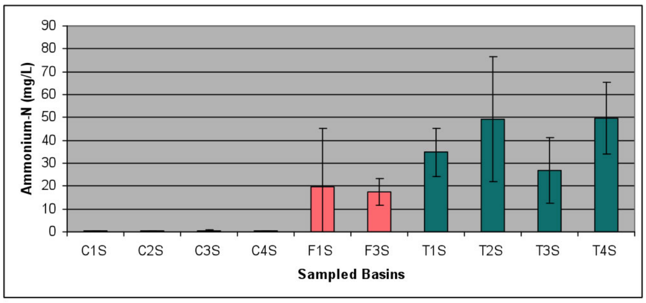
Orthophosphate-P Export



Control
Treatment (Winterfeed)

Figure 3.2 Average orthophosphate (PO_4-P) export from surface runoff water starting March 31 until April 19.

Ammonium-N in Runoff

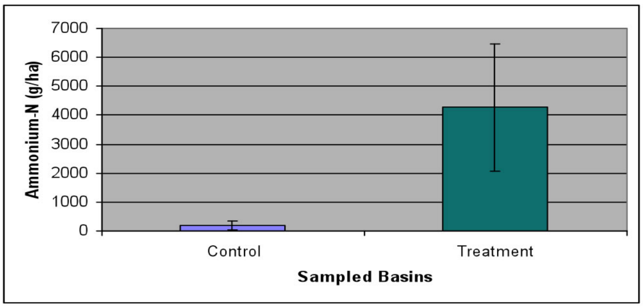


Control
Farm
Treatment (Winterfeed)

Figure 3.3 Average ammonium (NH_4-N) concentrations from surface runoff water starting March 31 until April 19.

Significantly higher ($P<0.05$) ammonium concentration in run-off from winterfeed watersheds.

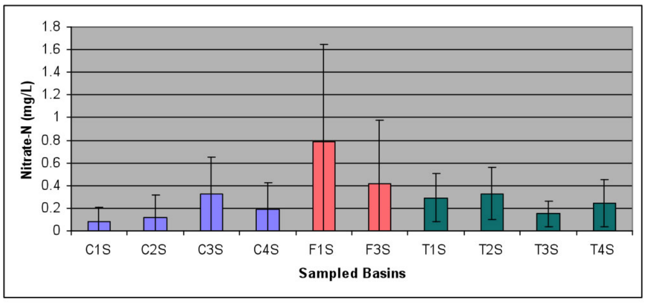
Ammonium-N Export



- Control
- Treatment (Winterfeed)

Figure 3.4 Average ammonium (NH_4-N) export from surface runoff water starting March 31 until April 19.

Nitrate-N in Runoff

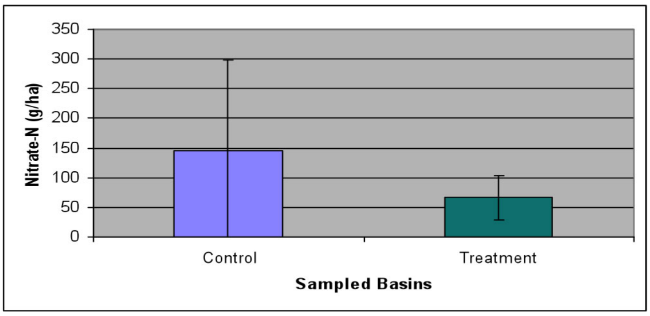


- Control
- Farm
- Treatment (Winterfeed)

Figure 3.5 Average nitrate (NO_3-N) concentration from surface runoff water starting March 31 until April 19.

No significant ($P<0.05$) difference in run-off nitrate concentration between control and winterfeed watersheds.

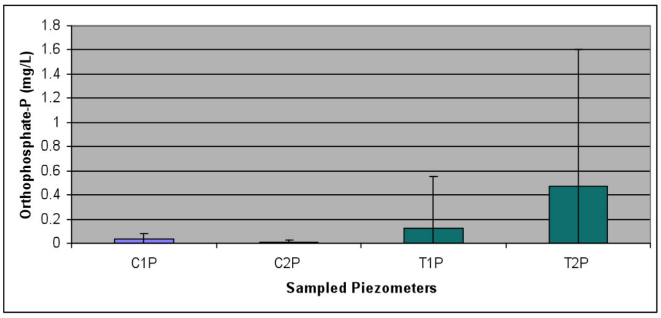
Nitrate-N Export



- Control
- Treatment (Winterfeed)

Figure 3.6 Cumulative nitrate (NO_3-N) export from surface runoff water starting March 31 until April 19.

Orthophosphate-P in Ground Water



- Control
- Treatment (Winterfeed)

Figure 3.7 Average concentration of orthophosphate (SRP) from piezometer water samples that were collected weekly from the beginning of April until the end of June.

Total Coliforms in Runoff

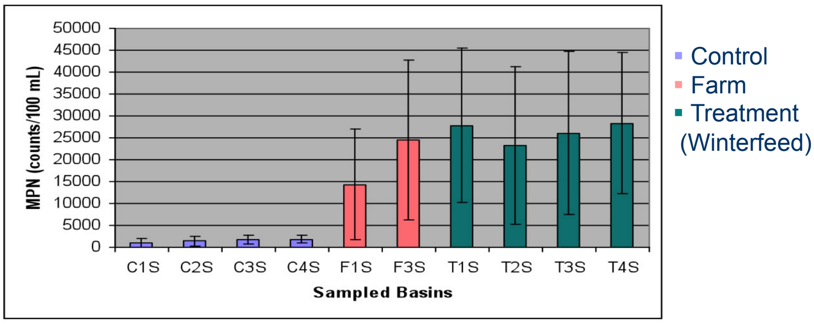


Figure 3.10 Average concentrations of total coliforms from surface runoff water starting March 31 until April 19.

Escherichia coli in Runoff

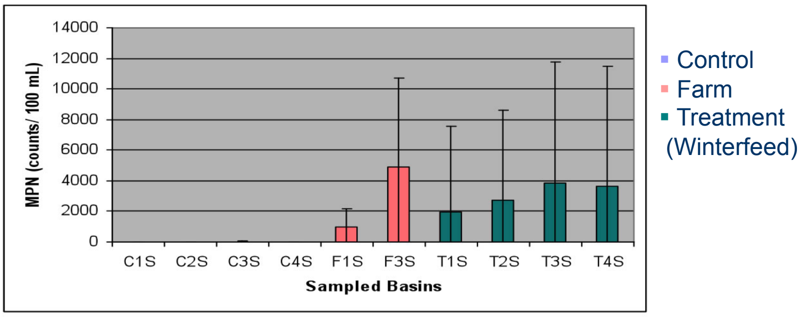
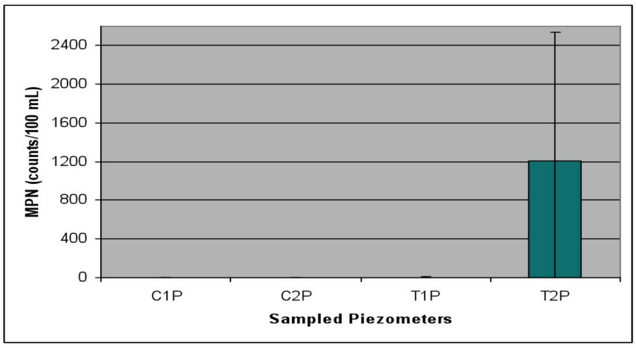


Figure 3.11 Average concentrations of *Escherichia coli* from surface runoff water starting March 31 until April 19.

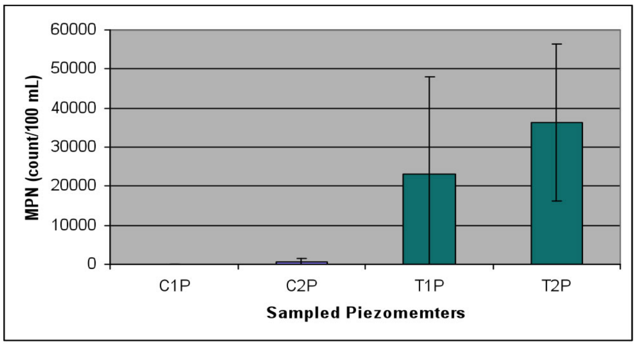
Escherichia coli in Ground Water



- Control
- Treatment (Winterfeed)

Figure 3.12 Average *Escherichia coli* concentration from piezometer water samples that were collected weekly from the beginning of April until the end of June.

Total Coliforms in Ground Water



- Control
- Treatment (Winterfeed)

Figure 3.13 Average total coliforms concentration from piezometer water samples that were collected weekly from the beginning of April until the end of June.

Phosphorus in Soil

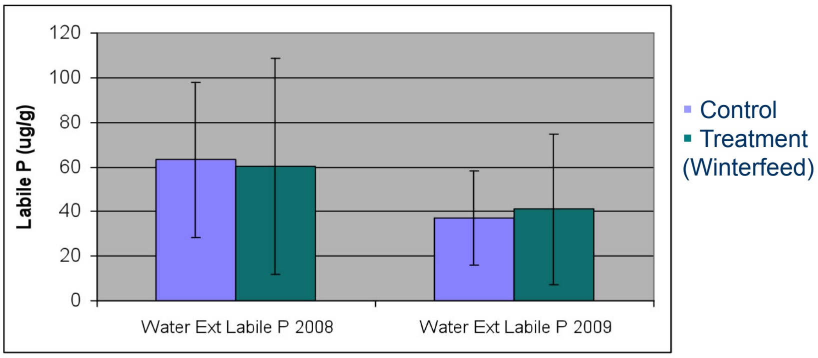


Figure 3.8 Average water extractable phosphate in soil samples collected from large treatment and control grid in fall 2008 and spring 2009.

Phosphorus in Soil

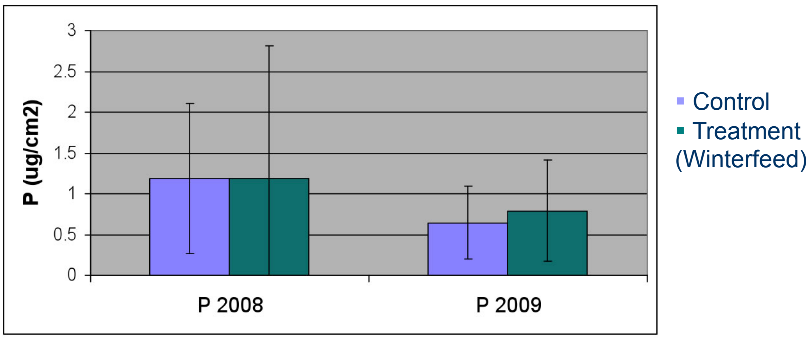


Figure 3.9 PRS probe (exchangeable phosphate) in soil samples collected from the large treatment and control grid in fall 2008 and spring 2009.

Nutrient Import from Manure

Total N	Total P
1.54 ton	0.51 ton
341 lb/acre	114 lb/acre

Table 3.1 Estimated import of total N and total P from the beef cattle manure on the winterfeeding site from December 8 until March 6.

Based on 887 cow/day/acre and estimating a total of 302 tons of manure added to the site.

Discussion

- 3 out of the 4 treated basins had calculated export of ammonium exceeding 3 kg/ha compared to Owen and Shipitalo (2009) average of 2.5 kg/ha in Ohio
- The average of the 10 largest events, the nutrient export reported by Owen and Shipitalo (2009) of 16.8 kg/ha of ammonium easily exceed the export found in this study.

Conclusions

- Ammonium and orthophosphate concentrations are elevated in runoff water from winter feeding sites.
  - Winter feeding sites should be located so as to avoid run-off water entering into sensitive surface and sub-surface water bodies.
- Similar nitrate concentrations in runoff water from control and winterfeeding sites may be explained by cool temperatures limiting microbial conversion of ammonium to nitrate.

Conclusions

- Lower soluble and exchangeable soil phosphate in spring compared to fall may be explained by plant and microbial uptake of P in spring.
- Lack of significant effect of winterfeeding on soluble and exchangeable soil phosphate suggests reduced potential for future transport of orthophosphate.