Agronomic application of cattle manure and compost on irrigated cereal silage

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**Introduction**

Nutrient management and application are required for optimum crop production.

Loss of nutrients from agricultural systems is a major environmental concern.
Intensive Agriculture
Nutrient budgets

**Imports**
- forage
- grain
- livestock
- fertilizer
- legume N$_2$ fixation
- manure
- atmospheric deposition

**Exports**
- crop products
- livestock
- manure

N surplus
P surplus

water quality impairment
**Eutrophication**

Is the natural process of lake aging, but can be accelerated by human activity.

- nutrient enrichment (P)
- extensive plant growth and decay
- reduced oxygen and cause fish kills
- toxicants from algae blooms
- restricts flow
- odour and poor esthetics
Median annual total phosphorus FWMC (mg/L)
Approach: Nutrient management planning

- Soil and manure sampling
- Lab analysis
- Nutrient application
- Feed testing & ration planning
- Keep records
- Crop rotation
Nutrient Balance:

- manure nutrients ≠ crop requirements

Nutrient Availability:

- the level of nutrient availability in manure is an estimate at best
Agronomic manure application study

Objectives

• Examine the effects of nitrogen-based and phosphorus-based application of fresh and composted cattle manure on soil chemistry and crop yield.

• Assess the nutrient management approach to applying organic sources of nutrients.
Field site

Dark Brown Chernozemic
Medium textured soil

Locations:
- Calgary
- Medicine Hat
- Lethbridge
- British Columbia
- Alberta
- Saskatchewan
- United States of America
Experimental treatments

- Control
- N fertilizer
- P fertilizer
- N + P fertilizer
- N-based manure
- P-based manure (+ N fertilizer)
- 3 x P-based manure/3 yr (+ N fertilizer)
- N-based compost
- P-based compost (+ N fertilizer)
- 3 x P-based compost/3 yr (+ N fertilizer)
Nutrient application rates were based on annual fall soil testing and fertilizer recommendations.
Inorganic nutrient sources

Fertilizer nitrogen
46-0-0 (urea; pre-seeding, spring banded)

Phosphorus fertilizer
0-45-0 (with seed)
Crop available N and P in manure

Manure

- NH$_4$
- NO$_3$

Organic N

- PO$_4$

Organic P

- NH$_4$
- NO$_3$

PO$_4$

gaseous loss

mineralized

residual

?
## Manure nitrogen and phosphorus

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<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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<tr>
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<td></td>
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<td>25</td>
<td>13</td>
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<tr>
<td>Compost</td>
<td>13</td>
<td>7</td>
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<tr>
<td><strong>% available phosphorus</strong></td>
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<tr>
<td>Compost</td>
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*as a % of the original amount of organic N applied

**as a % of the original amount of total P applied

Eghball and Power 1991; Eghball et al. 2002; Sharpley and Moyer 2002
## Soil nitrate-N (0-60 cm)

<table>
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<tr>
<th>Year</th>
<th>Cont</th>
<th>FN</th>
<th>FP</th>
<th>FNP</th>
<th>MN</th>
<th>MP</th>
<th>MP3</th>
<th>CN</th>
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**Soil phosphate-P (0-15 cm)**

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121 mg/kg PO₄-P (2007)

Zone of interaction - runoff water

Phosphate-P (mg/kg)

Soil depth (cm)

Manure-N treatment

0 50 100 150 200 250

15 cm

62 137 215 239 248

0 3 6 9 12 15 18 21 24 27

15 cm
Dry-matter yield - 2007 (barley)

Dry-matter yield (tonne/ha)

Treatment

Cont FN FP FNP MN MP MP3 CN CP CP3
## Manure and compost application rates

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<tr>
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<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td></td>
<td>tonne/ha</td>
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<td>29</td>
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<td>60</td>
<td>63</td>
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All rates on a wet-weight basis.
### N-based versus P-based rates

<table>
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<tr>
<th>Source</th>
<th>Rate</th>
<th>More land</th>
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<tbody>
<tr>
<td>Manure N (6 yr)</td>
<td>195 tonne/ha</td>
<td>6.6 x more land</td>
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<tr>
<td>Manure P (6 yr)</td>
<td>29 tonne/ha</td>
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<tr>
<td>Compost N (6 yr)</td>
<td>388 tonne/ha</td>
<td>9.9 x more land</td>
</tr>
<tr>
<td>Compost P (6 yr)</td>
<td>39 tonne/ha</td>
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Conclusions

• There was no net nitrate-N accumulation.
• N-based application of manure and compost caused rapid P accumulation.
• P-based application of manure and compost resulted in minimal to no P accumulation.
• Applying manure and compost based on nutrient management principles achieved optimum yield.
• A larger land base is required for the sustainable application of manure nutrients.

To evaluate the environmental effectiveness and economic costs of BMP’s at the farm scale in agricultural watersheds.
Soil test phosphorus: 250 to > 700 mg/ kg

- Stop manure application (P)
- Nutrient management for N
- Irrigation scheduling using AI MM
- Control system on pivot to reduce runoff
- Grass waterway
“Through carelessness or ignorance, or both, the most valuable part of the manure is allowed to drain away, finding its way finally to the creek or river, or, to the danger of the health of the household or stock, into the well.”

F.T. Shutt 1898
Canadian Dept. of Agriculture

“… it is of highest importance that the manure given by this vast number of animals should be economically handled so that the best possible use be made of the fertilizers it contains.”

Wm. Saunders 1896
Canadian Dept. of Agriculture