Nature and Availability of Nutrients in Manure

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Manure:

A resource:

Fertilizer: N, P, K, S, Micronutrients

Soil Builder: Organic Matter,
especially solid manures

Manure:

A challenge:

- **Dilute** e.g. Liquid hog effluent 0.1% N to 0.5% N
  Cattle penning manure 0.5% N to 1.5% N
  Liquid N fertilizer 28% N
- **Variable** Must test to know what is in it.
- **Restrictive** May not have the balance of nutrients needed by crops

  (Usually too much P relative to N)

How to Manage Manure?

- ✓ **As a Fertilizer**
  - ✓ **Know What's In It**
  - ✓ **Know How It Behaves**

All Manures Are Not Created Equal!

Liquid Effluents: High availability of nutrient in year of application, not much organic matter.

Solid Manures: Slow availability of nutrients, lots of organic matter, long-term soil builder.

Nature of Manure Nutrients

Nitrogen in Liquid Effluent

Availability of effluent N in year of application

Ammonium N (100% available) + Organic N (20% - 30% available)

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Phosphorus in Liquid Effluent:

- closely related to solids content: solids ↑, P ↑
  10% to 50% of P is readily soluble

Availability of effluent P in year of application

~ 50% compared to commercial P fertilizer.

P in manure *initially* quite strongly fixed in soil

– Repeated application can result in saturation of fixation sites.

Potassium, Sulfur, Micronutrients in Effluent:

Example: Liquid Swine Effluent

- 8 to 20 lbs K / 1000 gallons
  - Manures are good source of K, especially liquid effluents. Too much K uptake in forage can be an issue: tetany, milk fever
- 0.1 to 3 lbs S / 1000 gallons
  - S content of many effluents is low: high S demanding crops may benefit from additional fertilizer S.
- 0.05 to 0.5 lbs Cu, Mn, Zn / 1000 gallons
  - Micros often strongly fixed but over time, manures increase micronutrient metal availability.
- Sodium content 3- 8 lbs Na / 1000 gallons
  - Effects of repeated applications on soil sodicity and salinity should be monitored.

Soil electrical conductivity (salinity)

Treatment	*Electrical Conductivity dS/m*
Control	0.14
Low rate effluent	0.21
High rate effluent	**0.32**

No salinity issues apparent, but watch salt loading over time on poorly drained soils!

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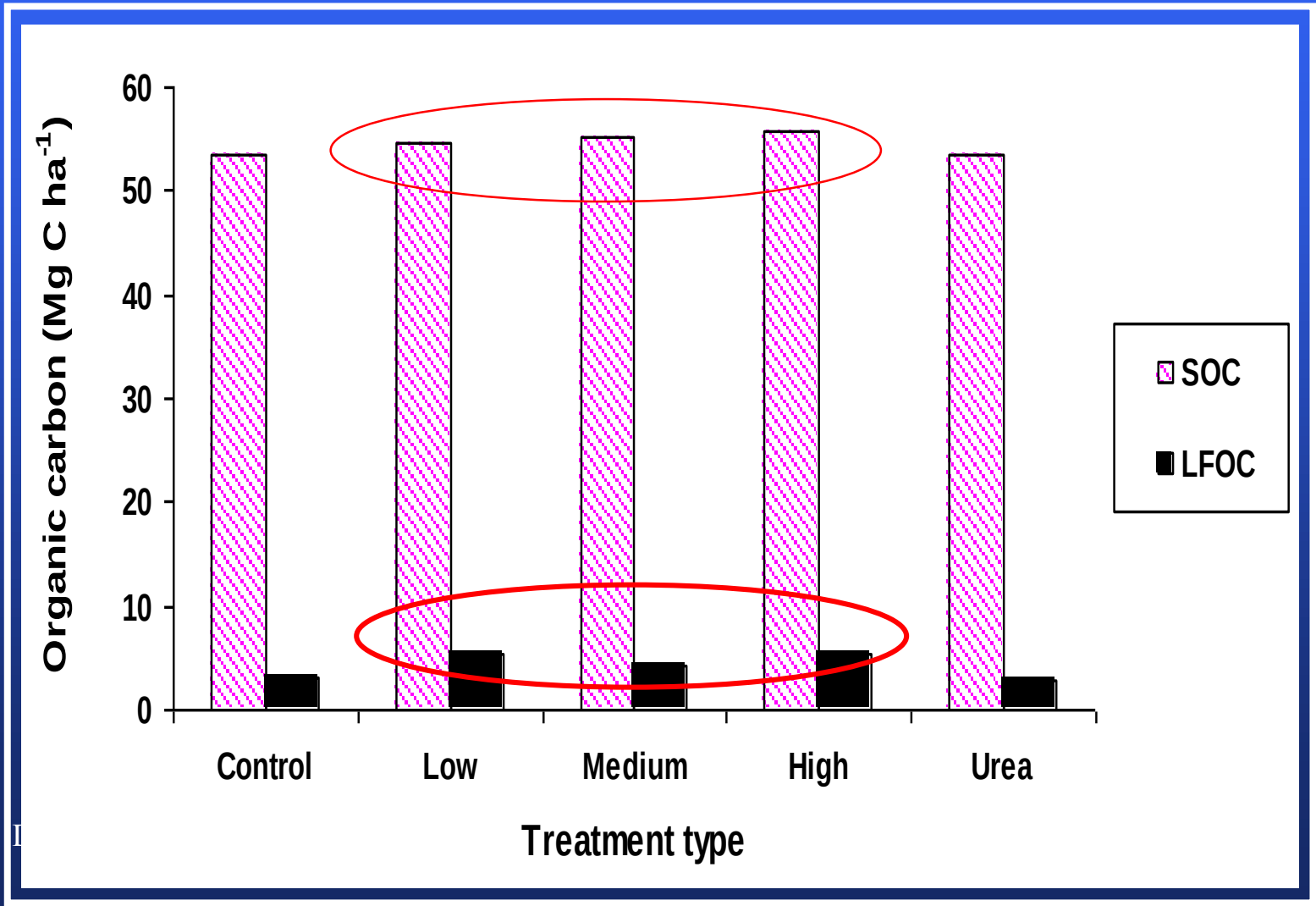
Solid Manures

- ~ 50 % water (varies!).
- Compared to effluents, much more organic matter: improves soil tilth, slowly increases nutrient supply power.

Long-term soil builders  soil organic matter

Carbon Sequestration!

Soil organic C contents (T/ha 0-15cm) in a Black Chernozem after 7 yearly applications of Cattle Manure at 15, 30 and 60 T/ha (6.7, 13.4 and 27 tons/acre)



- **Majority of Nitrogen in solid cattle manure is in the organic form, associated with carbon.**
  - **-Requires mineralization to be released.**

- **Release** of organic manure nutrients into **plant available inorganic forms** like **ammonium and nitrate can be slow**, especially for penning manure that contains lots of straw bedding.

- ***10-20% release of available N in year of application*** *is typical for feedlot cattle manure in Northern Great Plains.*

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C:N ratio of manure is driving factor affecting available N release

- Negative relationship between cattle manure organic C:N ratio and mineralization.

C:N ratios in manure or compost of < 13 we saw net release of available N over 10 wks, while > 15 showed temporary tie-up of available N.

Solid cattle manure of high C:N applied every year for eight years in Black soil zone of Saskatchewan, sampled at end of 8 years.

	0-2ft	2ft-3ft	3ft-4ft	4ft-5ft
	---------- lb/acre soil nitrate ----------			
~100 lb N/ac/yr (10 T/ha)	16	3	5	7
~400 lb N/ac/yr (40 T/ha)	24	6	9	14

Still lots of organic N added as cattle manure that has not mineralized to available inorganic forms yet. Continued application at high rate is anticipated to eventually result in mineralization rates that exceed crop use.

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N:P Ratio

Some Livestock Manure	Crop Uptake
3-5:1	8-10:1

Application of P - rich manure based on crop N requirements = residual P

P Balance at Dixon Solid Cattle Manure Site from 1997-2004

Treatment	Total P		
	Inputs† (A)	Outputs‡ (B)	Net (A-B)
	kg P ha^{-1}		
Control	0	32	-32
7.6 T ha^{-1} B&I§	265	52	213
15.2 T ha^{-1} B&I	531	72	459
30.4 T ha^{-1} B&I	1062	90	972
112 kg N ha^{-1} Urea	0	73	-73

† Calculated from manure P concentration applied each year

‡ Calculated from grain yield multiplied by %P concentration in grain

§ B&I denotes broadcast and incorporate application

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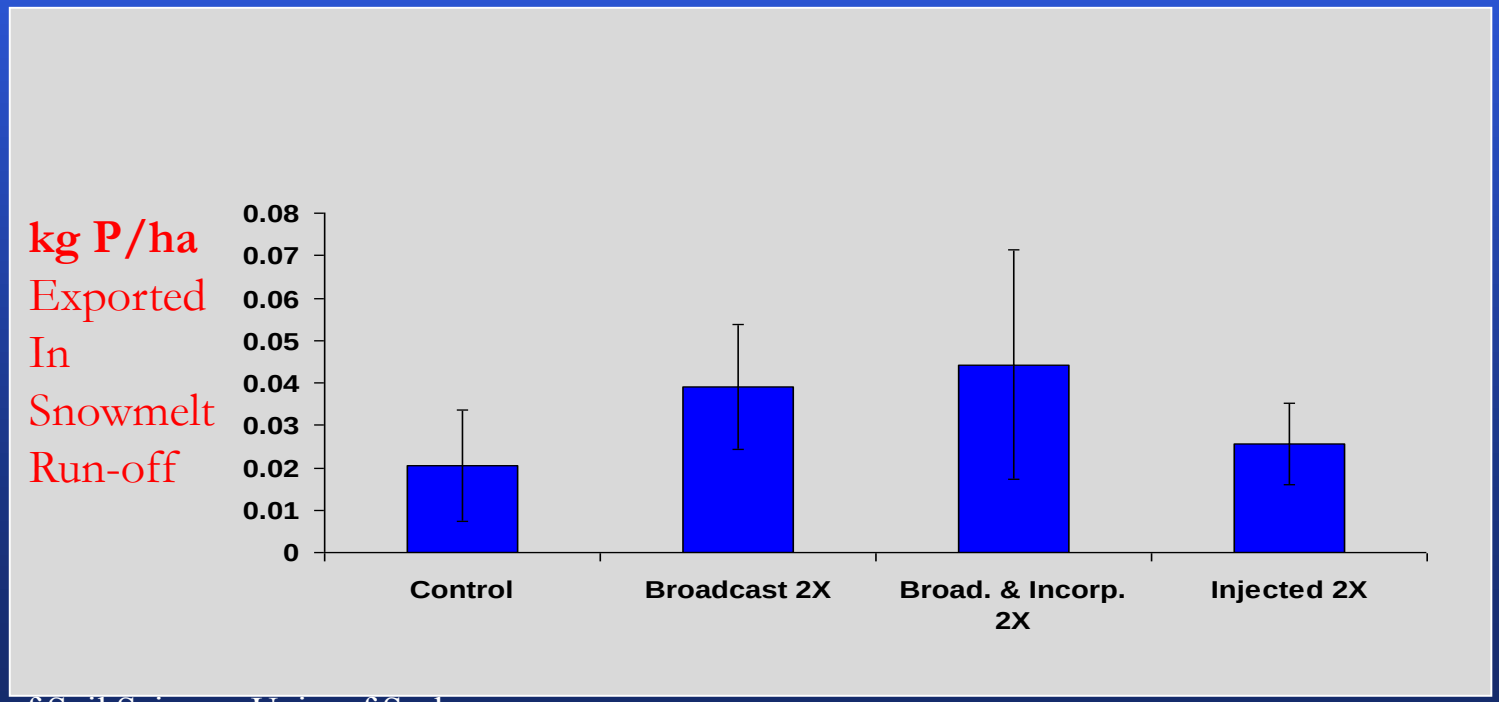
Phosphate (kg P/ha) removed in simulated snowmelt run-off from soils receiving cattle manure applied at 40 T/ha for two years



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Method of Application

- Manure applications to surface generally result in higher losses compared to injection or incorporation:

  Benefits to in-soil placement: Ammonia volatilization losses reduced. May also reduce removal of nutrients in surface run-off water.

  But injection of liquid manure can promote nitrous oxide production!

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Concluding Points

- By adding nutrients and organic matter, manure addition at agronomic rates has a **positive effect on nutrient availability, plant growth and soil quality**. Some fine tuning can improve responses, economic return.

- Knowing forms and composition of manure, effects of rate, placement, timing can **increase efficiency of manure nutrient utilization** by crops.

Thanks for opportunity to participate in 2017 Lethbridge Nutrient Workshop!

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