Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Circular Nutrient Economies – Agriculture Reality Check

Christine Brown, OMAFRA

D. Keith Reid, AAFC

National Nutrient Recovery Platform Workshop

8 March, 2018

Ontario

Canada

Outline

There is more than one way to "close the loop" on nutrient cycling

- "Traditional" On-farm nutrient cycles
- What is the situation today?
- Broadening the nutrient cycles – Farm to Farm
  - Challenges and Opportunities
- Broadening the nutrient cycles – Urban to Farm
  - Challenges and Opportunities
- Looking ahead

On-Farm Nutrient Cycling –

Options when On Farm Nutrients are out of balance

- Too many nutrients
  - Increase land base
  - Reduce manure nutrients through ration balancing
  - Sell or give away manure to neighbours
  - Manure separation
  - Manure processing
- Too few nutrients
  - Increase purchased fertilizer
  - Import manure
  - Import other organic sources

Each time a material is handled the "end product" cost increases

Challenges and opportunities with manure export

- Storage, handling & application costs, since manure is bulky
- Equipment availability; time windows for application
- Price of manure may be less than value of nutrients
- Exported manure may contain nutrients that the home farm needs, as well as nutrients that are in surplus
- Neighbouring farmers must have capacity to use the manure nutrients – it doesn't work well if the livestock farm is surrounded by other livestock farms

Challenges and opportunities with manure separation

- Nutrient profiles of solid fraction very different from liquid fraction
- Solid fraction high in organic matter, organic (slow release) N and phosphorus – can be exported if farm has excess of P
- Liquid fraction high in ammonium N (rapidly available but volatile) and potassium
- Requires equipment and storage to handle two different materials
- Separation equipment is relatively inexpensive but not free; requires regular maintenance

Liquid – Solid Separation – an Example

Water is the most expensive manure "nutrient" to transport – separating out the water would solve many problems

Example: Average Liquid Dairy Manure:
8.5 % Dry Matter → liquid/solid separation to 90% DM

6,000 gal tanker
145-83-135 lbs available N-P-K
1 load covers ~1.5 acres
Cost ~ $40/acre

10 ton spreader
400-347-566 lbs available N-P-K
1 load covers ~ 6 acres
Cost ~$ 8.00/acre

Low P, high K liquids can be summer applied to forages or corn fields

Neighbourhood Nutrient Management Planning

- **Threat of regulations "stick" with economic "carrot"**
- Moves manure from areas of high fertility to areas of low fertility
- developed cooperatively with livestock and cash crop farms with third party 4R consultant - paperwork, (maps, crop rotation schedules, manure analyses and soil tests)
- manure analyses would pre-determine value of available N, $P_2 0_5$, $K_2 0$
- explore opportunities
  - community storages,
  - pipe-lines (applying manure from central location) to decrease transportation costs / road issues

Manure Value – Application to Fields with High v.s. Low Soil Fertility

Manure	Dry Matter	Nitrogen		P_2O_5[1]	K_2O	Net Value (after application)[3]		
		Fall Applied	Spring Applied			High Fertility Field	Low Fertility Field	Rate[2]
Liquid manure	%	lb/1000gal				$/acre	$/acre	/acre
Swine (SEW)	1.7	8.5	16	11	12	($ 58)	$ 16	8,000 gal
Swine (Finishers)	5	18	33	28	29	$ 6	$ 127	5,000 gal

Value of **available nutrients** minus cost of application

It takes years to see payback on P & K on high fertility soils

[1]Total available P_2O_5. At least half of the P will be available in the year of application

[2] Applied for a corn crop - rate could increase soil test P between 1 - 2 ppm

[3] Net value doesn't account for distance between storage and neighbouring fields.

Values are based on application cost of $0.015/gal or $4/ton; incorporated within 24 hrs and based on N-P-K equivalent where N is $0.41/lb; P_2O_5 is $0.57/lb and K2Ois $0.36/lb. OM & micronutrient values not included.

Crop rotations in application plan - minimize compaction and maximize nutrient efficiency - manure to a growing crop or post wheat with cover crops

Benefits of a neighbourhood nutrient management plan

- Manure can be applied to fields that require nutrients and OM at times that maximize nutrient utilization
  - Low value liquid manure could be applied for water benefit to forages
  - Low value solid manure could be transported to low OM soils
- Farms receiving manure could trade straw and/or pay the cost of the fertilizer equivalent value of available nutrients in exchange for micronutrients and OM. Application costs will depend on manure type and distance travelled
- The livestock operator receives financial benefit for nutrients that would take many years to provide a pay-back
- consultant helps with the planning, record keeping, sampling, nutrient balancing with fertilizer, etc., and would be reimbursed through the neighbourhood group and would maximize potential

Challenges and opportunities with manure processing

- End products can be segregated more completely into product classes
- Nutrient concentration of some, but not all, materials higher than manure, so transportation is less of a barrier
- Opportunity to retain organic materials on farm with minimal nutrient loading
- Capital cost for processing equipment very high – needs a lot of manure to justify
- Product quality high enough to enter fertilizer stream???

Challenges and opportunities with processed biosolids

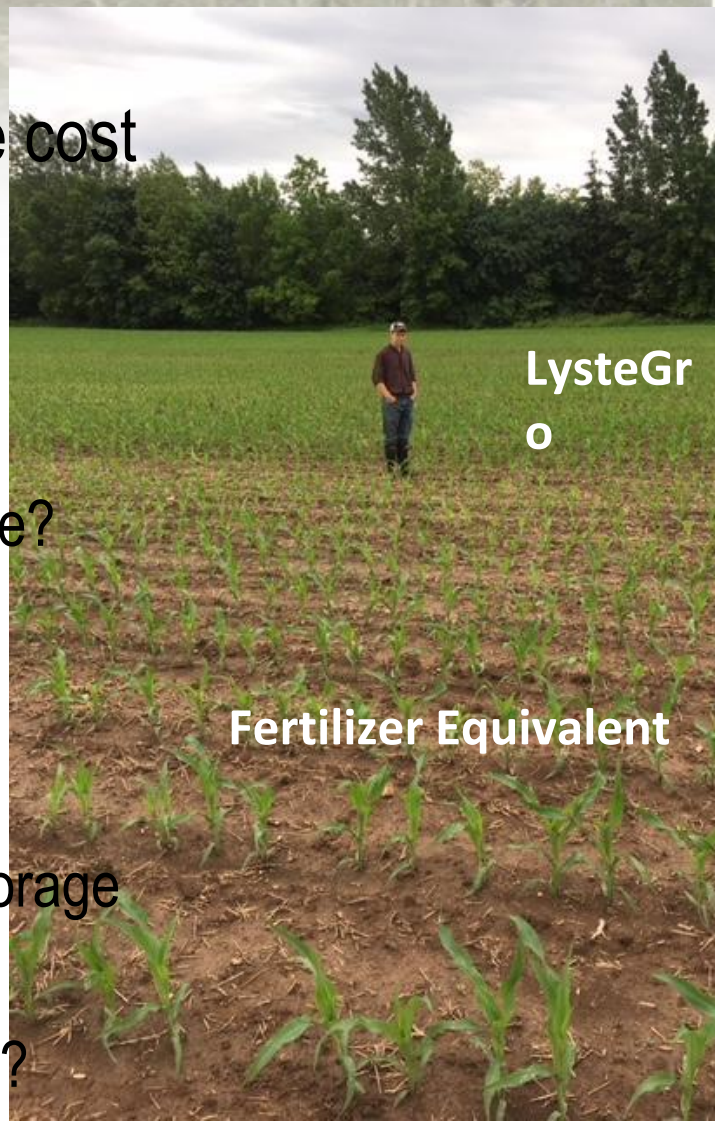
- Moderate nutrients + organic matter
- Available to crop producers - reasonable cost

(includes transportation & application)

- Ideally applied to fields with low fertility
- Produced all year, however
  - Does material meet the needs of marketplace?
  - Matching marketplace needs for P vs K vs N

  Example: **Biosolids pellets**
  - Application in summer vs winter (or landfill)
  - Material risks spontaneous combustion in storage
  - Ensuring environmental safety:

  Is it responsibility of processor or marketplace?



Challenges and opportunities with anaerobic digestate

- Dilute nutrients – liquid fertilizer source
- Available to crop producers (includes transportation & application)
- Example: **Municipal Anaerobic Digestate**
- ~3% DM; 30-10-11 lbs available N-P-K /1000 gallons
- Produced all year, however

  Application restrictions on frozen, snow-covered and saturated soils = high storage needs

  - Does material meet the needs of marketplace?
  - Matching marketplace needs for P vs K vs N

  Niche market opportunity? - liquid fertilizer vs OM source

  e.g. Mix liquid + leaf-yard waste to increase nutrient density & reduce storage costs

Challenges and opportunities with recovered nutrient products (e.g. Struvite)

- Solubility and nutrient availability relative to fertilizer
- Physical condition of product (compatibility for bulk blending requires consistent and specific granule size)
- Price relative to fertilizer, and willingness of market to pay a premium (market segregation, and size of market)
- Quantities available, relative to throughput at a commercial fertilizer blending facility
- Seasonality of demand relative to production of material; storage facilities and costs

What's in store down the road

- If fertilizer phosphorus costs increase significantly, the equation shifts towards recycled materials
- Time horizon for "Peak P" has been pushed back several decades, but many remaining reserves are in politically unstable areas
- There is more than one way to "close the loop" on nutrient cycling

Questions and Discussion