Phosphorous Deficiencies on Canadian Organic Farms

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Excess P in East of N. America

Dairy Farm Nutrient Budgets

Production System	# Farms	Stocking Rate (LU/ha)	Herd Production (kg/cow/y)	Net P surplus (kg/ha/yr)
Confinement	20	2.00	9455	36.7
Pasture-based	23	1.22	6973	11.3

Anderson and Magdoff, 2000

Systems-Based Approach

Inputs

Animals

Feed

Fertilizer

Outputs

Milk,
Meat
Straw
Manure
Animals

Internal nutrient flows

External nutrient flows

Impact of Diet on Manure N:P ratio

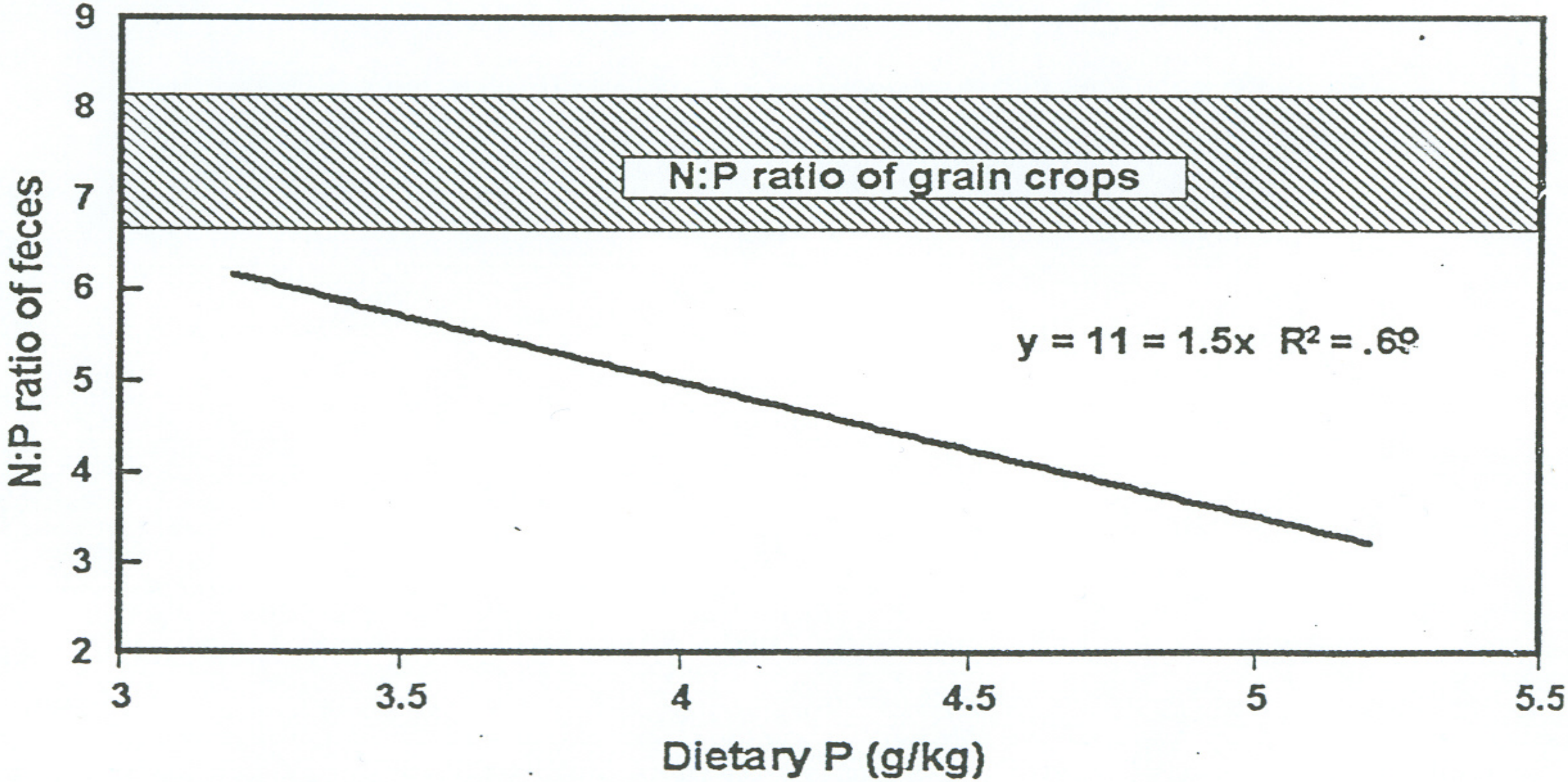

Figure 2. Dairy diet effect on N:P ratio of feces.

Powell et al., 2001

Integrated Nutrient Management; A Case Study from Atlantic Canada

Herman Mentink, Kipawo Holsteins, Grand Pre, Nova Scotia

Since 1988, production system changes and systematic approach to soil fertility. Commercial fertilizers were no longer used.

Lynch, D.H, Jannasch, R, Fredeen,A,H. and Martin, R.C. 2003. Am. J. Alt. Ag. 18: 1-9

External Nutrient Budget (2000)

		N (kg)	P (kg)	K (kg)
INPUTS	Feed	4492	970	1076
	Seed	60	7	10
	Manure	974	746	545
	N2 fixation	6953	-	-
	N deposition	797	-	-
OUTPUTS	Milk	2922	525	641
	Meat	402	14	3
% EXPORTED		25.0	31.2	37.3

Soil Fertility (1985-2000)

NUTRIENT (mg/kg)	1985	2001
P	117	151
K	291	166
Ca	1293	1488
Mg	568	279
OM (%)	3.3	3.9

1985-2000: Gains in soil test P of 2 mg kg^{-1} yr^{-1}

Resolving P surplus on the Mentink Farm

Since 2001:

- avoiding manure imports
- reduced dietary P 10-20% (from 5 to 4 g P kg -1 DM)

Farm P surplus in 2000: 9.0 kg P ha-1 yr-1

Farm P surplus in 2001: 2.6 kg P ha-1 yr-1

P Deficiencies on the Prairies

- Most organic farms on the prairies export grain.

- On all 46 organic farms (84 organic fields, 19,000 ha) surveyed in Saskatchewan, available P was deficient or severely deficient.
- Even fields at pH 5.5, had deficient levels of 16 to 22 lbs/acre
- Rock P applied on 8%,

  manure on 12% and

  Penicillium bilaiae on 1% of farms.

(Knight and Shirtliffe, 2003)

- In Manitoba (14 organic farms, 170 fields), available P levels were low on all fields and especially on those farmed organically for 30 years or more (Entz et al., 2001).

- Brandt (2003) and Entz (2003) also noted depletion of available P in organically managed research plots at Scott, SK and Glenlea, MB, respectively.

- Apparent depletion of P within the first 3 years of transition (Knight 2004). Are there factors beyond depletion?

P Deficiencies on Organic Farms in Ontario

- **Characterized farm and soil nutrient status, on 15 long term (>10y) organic dairy farms (225 fields).**

- **Soil test (0 .5M $NaHCO_3$) P levels were low to very low (<10ppm) on over 60% of farm fields tested.**

- **7 farms were low to very low (<8ppm)**
- **4 farms were medium (8-13 ppm).**

- **In contrast, available K levels were moderate to high.**

- **Low available P levels across all management systems, showed only a weak relationship (R^2 = 0.36) between farm stocking rate (nutrient intensity) and soil test P.**

- **Why does the Mentink farm without fertilizer still have an annual P surplus when organic farms show a P deficit?**

- **Probably organic dairy farms import less feed with more reliance on on-farm forages and they seldom import manure.**

Will Phosphate Rock Meet the Deficit?

- Igneous phosphate rock (PR), approved for use in organic production, now commercially available in Ontario. P content varied from 1.4 (Carbonatite) to 16.8% (Vocanaphos) with little (<1%) available P. Contaminant (Cd, As) content was low.

- Plots at 3 sites to assess the P supplying ability of 2 Ontario igneous (Carbonatite, Volcanaphos) and 3 imported marine mineral P sources (Calphos, Tennessee PR, and Pebbled PR).

- The soils were alkaline, typical of organic farms in Ontario and thus buckwheat was used as a test crop.

- Effectiveness of PR on buckwheat yields, increased with PR solubility, except where PR grain size was relatively large (Pebbled PR).

- Buckwheat yields increased under PR's Calphos, and Tennessee PR, plus fertilizer TSP. Higher yields at all rates (100-800 kg P ha-1) of MAP, combined (N+P) fertilizer.
- Carbonatite and Volcanaphos (Ontario PRs) largely failed to improve buckwheat growth.

Solving the P Deficit

- Is the widespread use of raw PR viable and is it ethical to use fossil fuels to haul huge volumes of low-concentrate P across N.A.?

- Can we concentrate (i.e. acidulate) rock P at source by using anaerobically derived citric acid or other biological processes (Peter van Straaten at U of Guelph)?

- Will the co-application of elemental S and PR, make P from PR more available?

- **What are the certification implications of recycling pelletized P from conventional feed-lot manure?**

- **What is the risk of using manure from feed-lots with GMO feed and will composting reduce the risk?**

- *Penicillium bilaiae* **was very effective at making soil P available in a greenhouse trial and less so under drought in the field (Knight 2004, unpublished).**

- Is the 0.5M $NaHCO_3$ extraction in triplicate, the appropriate test for assessing available P in organic systems?

- Is there really a P deficit?

- Prairie Organic farmers suggest it is really just a question of availability.

- A better understanding of soil biology may provide the answers

Summary

- There is a P surplus on most livestock farms in Eastern North America.
- Prairie Organic farms (often grain exporting) have P deficits
- Ontario Organic dairy farms also have P deficits

- PR and feedlot manure may partially meet the P deficit but at what cost and how effectively?

- How long will it take on organic farms to deplete available soil P ?

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