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SOIL FERTILITY AND NUTRIENT BUDGETS ON ORGANIC DAIRY FARMS

Interim Research Report E2006-12

INTRODUCTION

Dairy production systems face unique nutrient management challenges. Most dairy farms run large nutrient (NPK) surpluses as a result of high nutrient imports (mostly as feed) relative to farm nutrient exports (mostly as milk). For example, studies in the north-eastern US found that on conventional dairy farms with livestock stocking rates of 2.0 animal units per hectare, phosphorus was accumulating at an average rate of 36.7 kg P per hectare per year (Anderson and Magdoff, 2000). In contrast, on organic and pasture-based dairy farms with 1.2 animal units per hectare, the phosphorus surplus was considerably smaller (10.4 kg P per hectare per year). Data from Europe suggests that some organic dairy farms may develop phosphorus deficiencies. Loes and Ogaard (2001) reported on long term trends (6 to 12 years) in phosphorus on five organic dairy farms in Norway. They observed a trend in decreasing topsoil phosphorus concentrations for all farms with negative farm P balances (imports-exports) over the same period.

In Ontario, the number of organic dairy farms and the demand for organic dairy products has increased dramatically over the past decade. As production grows, there is a need to look more closely at the nutrient efficiency of these dairy management systems. In collaboration with the University of Guelph, the Organic Agriculture Centre of Canada (OACC) is characterizing the nutrient status of Ontario organic dairy farms in order to more closely link livestock and crop nutrient requirements with soil fertility status.

The **objectives** of this project were to:

- Describe farm management parameters on 15 organic dairy farms
- Characterize current soil fertility and investigate historical trends in soil fertility
- Model whole farm nutrient (NPK) mass balances for 2003 and 2004

Soil sampling on an organic dairy farm (K. Maitland)

WHAT WAS DONE

In fall 2003 and spring 2004, a farmer survey was conducted to characterize farm management (farm size, crops, organic certification timeline, animal husbandry characteristics and feeding regime). We collected data from 15 organic dairy farms (33% of the provincial total) in 9 different counties in Southern and Eastern Ontario. A partial summary is presented in Table 1.

Farm-gate nutrient budgets were conducted for all farms over two years. The nutrient content of all managed inputs and outputs were characterized either from direct analysis, from farm records, or estimated from book values where no sample was available. The nutrient composition of imported mineral supplements was obtained directly from the manufacturer while milk and meat exports were quantified and book values used for nutrient content. Legume N_2 fixation and atmospheric N deposition were estimated. The soil survey consisted of taking one composite topsoil sample (0-15 cm) from fields on each farm (avg. 80% of fields sampled). The soil was analyzed using provincial standard soil testing methods, and the study weighted average is reported.

Soil phosphorus (0.5M $NaHCO_3$) levels were low to medium. Seven of the farms averaged in the low to very-low range (<10 mg P kg^{-1}), six farms were in the medium range (10-20 mg P kg^{-1}) and two farms were in the high range (>20 mg P kg^{-1}).

Table 1. Characteristics of Ontario organic dairy farms participating in the research

	Farm Size (ha)	Cows[1]	Stocking Rate (AU ha^{-1})	Milk Production (kg cow^{-1} year^{-1})	Crop production in 2003 (% of farm)			
					Forage	Small grains	Corn	Soy
Mean	111	52	0.98	7960	64.6	24.5	6.5	3.5
SD	56	23	0.25	1107	21.0	14.4	7.5	6.8
Min	45	24	0.48	6129	29.3	0.0	0.0	0.0
Max	235	99	1.45	9348	100.0	42.0	23.4	21.1

[1] **Including lactating and dry cows**

However, the Ontario soil test P method may not be appropriate on organic farms where soil organisms may play a larger role in nutrient cycling. The average soil K (ammonium acetate) levels were medium (108 mg K kg^{-1}). Most farms (11) fell in the medium range while four were in the high range (>120 mg K kg^{-1}). The average soil organic matter (SOM) content was 4.84% (range 3.87 – 5.87), and soil pH was 7.42 (range 6.23 – 7.90).

Table 2. Farm gate nutrient budget data for Ontario organic dairy farms, 2003-04

	Average Surplus (kg ha^{-1} yr^{-1})			Average Soil Fertillity (ppm)	
	N	P	K	P	K
Mean	54	0.9	11.1	12.2	108.0
SD	21	3.0	16.4	7.3	25.7
Min	18	-2.5	-13.7	5.3	68.3
Max	103	7.6	57.1	28.1	160.1

CONCLUSIONS

Organic dairy farms in Ontario are productive and efficient at nutrient cycling - exporting a substantial proportion of nutrient inputs as saleable farm products while avoiding excessive soil nutrient loading. In contrast to many large intensive dairy operations, these farms have a smaller potential to be significant sources of nutrient losses to the wider environment. However, care must be taken to maintain K levels and maintain or increase P levels to promote healthy legume growth and associated N fixation. Further research is required to ascertain whether standard soil tests are appropriate measures of soil nutrient availability in organic dairy systems.

REFERENCES

Anderson, B.H. and F.R. Magdoff. 2000. Dairy farm characteristics and managed flows of phosphorus. Amer. J. Alternative Agric. 15:19-25.

Loes, A.K. and A.F. Ogaard. 2001. Long term changes in extractable soil phosphorus (P) in organic dairy farming systems. Plant Soil 237(2):321-332.

THE BOTTOM LINE...

Although average soil K levels on all farms tested adequate, approximately half of the farms tested low to very low in available P. Our farm nutrient budgets support the soil data, showing yearly average K surpluses approximately 10 times larger than yearly average P surpluses. The budgets also show that N fixation accounts for the majority of N inputs.

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CREDITS

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