GRAND RIVER CONSERVATION AUTHORITY NUTRIENT MANAGEMENT PILOT PROJECT

1994

CURB

CLEAN UP RURAL BEACHES

LORI GORDON

GRAND RIVER CONSERVATION AUTHORITY

TABLE OF CONTENTS

ABSTRACT

This Pilot Project was initiated to examine the possibility of implementing the Nutrient Management Computer Program into the Clean Up Rural Beach (CURB) program. The importance of nutrient management, labour requirements of the computer program and landowner concerns were examined. Nutrient management is the management of nutrients on a land base to ensure reasonable crop production while minimizing offsite impacts (Shuyler, 1994). Nutrient management has many advantages which depending on the situation may include: the reduction of nutrient loading into streams and ponds, the protection of groundwater reserves, and the possible reduction in fertilizer use. The possible reduction in fertilizer may reduce the costs of crop production as well as ensuring the efficient use of resources (Shuyler, 1994).

This project involved collection of 66 manure samples and all samples underwent analysis for nitrogen, phosphorous, potassium, percentage dry matter and ammonium nitrogen. For all samples the "Nutrient Management Computer Program" aided discussions of Nutrient Management with landowners.

The Nutrient Management Computer Program is a development of the Ontario Ministry of Agriculture Food and Rural Affair (OMAFRA) to aid extension workers with nutrient management discussions. The program considers the crop requirements and contrasts these with the nutrient availabilities to determine the nutrient status of individual fields.

On average the time requirement for manure sampling was one half hour to a full hour while the computer program took from a half hour to three hours to complete with landowners. Landowners were generally very eager and interested in the information provided to them in this time frame. Through the discussions a number of information gaps in the program were discovered.

The completion of the Nutrient Management computer program often led to discussions of nutrient management related matters and concerns. These discussions included such topics as the differences in nutrient values between roofed and non-roofed manure storages, composting and different cropping practices often emerged from the discussion of nutrient management.

The Nutrient Management Computer Program aids and compliments nutrient management discussions. It is recommended that the program be used in the Clean Up Rural Beaches Program to aid in the discussion of manure and nutrient management on the farm.

INTRODUCTION

Nutrient management is the management of nutrients on a land base to ensure reasonable crop growth while minimizing off site impacts due to nutrient transport (Shuyler, 1994). Nutrient management will help ensure the protection of groundwater, reduce nutrient loading into streams and may help reduce the costs of agricultural production by reducing the amount of inputs such as fertilizer (Shuyler, 1994). Nutrient management does not always infer the reduction of nutrient use since the goal of nutrient management is to ensure reasonable crop growth and should therefore ensure efficient nutrient use (Shuyler, 1994).

The performance of effective nutrient management is on a field by field basis. This involves knowing the nutrient requirements of a crop, previous crops grown and previous manure applications to determine the unfulfilled nutrient requirements of the crop. Generally, nutrient management concerns with nitrogen, phosphorous and potassium yet, other micro nutrient deficiencies or excesses can occur in a field. These nutrient requirements can be filled by using manure and/or fertilizer applications. It may not be advisable to supply the balance of the crop's nutrient requirements from manure since with manure some nutrients may be oversupplied. For example if you are attempting to satisfy the crop's nitrogen requirements you may exceed the amount of phosphorous and potassium being applied. Over application of nutrients can cause environmental problems due to surface runoff and nutrient leaching. Some environmental problems that caused by runoff and leaching include: Ammonia (NH_3) toxicity in fish, contamination of groundwater by nitrate making groundwater unsafe to drink for young and elderly humans and animals, and eutrophication of surface water bodies. Over application of nutrients can also reduce crop yields since excessive nutrient levels can be toxic to plants.

Some landowners feel that they can apply nutrients in excess of the recommended rates with the hope of receiving increased yields (Agriculture Canada, 1994). This belief that increased inputs will improve yields does not take into consideration costs as compared to profits or environmental quality. Discussions regarding nutrient management can increase the understanding of: the importance of nutrients to crops, the behaviour of nutrients in soil, the sources of nutrient additions to the soil and factors such as incorporation that influence nutrient supply (Agriculture Canada, 1994).

The utilization of manure has many benefits. Manure is an excellent source of macro and micro-nutrients for crop production. A manure application consists of nutrients in inorganic and organic forms.

Nutrients in the inorganic form are readily available for use by plants. Organic nutrients must be broken down to inorganic forms for plant use. The breakdown of manure from organic to inorganic nutrient forms leads to residual nutrients being made available for several years after the initial manure application. A third benefit of manure additions to fields is that manure provides organic matter to fields and organic matter additions can improve soil structure, soil nutrient holding capabilities, soil water holding capabilities as well as assisting with improving the drainage of a field (Agriculture Canada, 1994). The benefits of manure additions to a field show that manure is a valuable resource to be handled with care.

The nutrient content of manure varies depending on the type, breed, age, sex and health of the livestock, the storage being used, and the feed and bedding types used for the livestock. The variability in manure nutrient content is evident when looking at the summary of the analysis results. Due to this variability and the lack of knowledge on manure nutrient content many landowners do not know the nutrient content of their manure. Since the nutrient content of manure is often not known many landowners may be inefficiently using nutrients on their farms. Inefficient nutrient use often leads to surface runoff and leaching. This pilot project was initiated to increase awareness of nutrient awareness and as such reduce offsite impacts of improper nutrient management as well as increase the value of manure on the farm as a resource..

The Nutrient Management Pilot Project is funded by the Ministry of the Environment and Energy involving the Clean Up Rural Beaches Facilitators and applicants in the Grand River Conservation Authority, Ausable Bayfield Conservation Authority, Maitland Valley

Conservation Authority and the Upper Thames River Conservation Authority. The manure nutrient management pilot project involved the sampling and analysis of manure in manure storages. Manure samples were analyzed for nitrogen, phosphorous, potassium, percentage dry matter and ammonium. Analysis results were used to complete the Ontario Ministry of Agriculture, Food and Rural Affair's (OMAFRA's) newly released Nutrient Management Computer Program. The Nutrient Management Computer Program is an excellent tool in the discussion of nutrient management on the farm.

The nutrient management computer program allows each field to be analyzed individually to determine the fields nutrient status. For each field the crop nutrient requirements are compared to the nutrients available from previous crop production and previous manure applications as well as current manure applications to determine the fertilizer requirements of that field.

OBJECTIVES OF THE NUTRIENT MANAGEMENT PILOT PROJECT

1. To determine if the Manure Computer Program could be implemented into the Clean Up Rural Beaches (CURB) site visits

2. To determine how the nutrient availabilities differ between types of storages

3. To determine if landowners are interested in the information made available from the manure analysis and the computer program.

4. To determine the time required to conduct the manure sampling and the run the Nutrient Management Computer Program (NMANPC) computer program

5. To determine landowner concerns with the implementation of this type of program

6. Add data information to the manure management computer program

METHODOLOGY

1. Gather information on manure management.

2. Compiled a list of landowners, active in CURB, to be contacted for the pilot project. This list was compiled from the: Grand River Conservation Authority, Ausable Bayfield Conservation Authority and the Upper Thames River Conservation Authority.

3. Manure analysis was completed at the Land Resource Science Lab at the University of Guelph. The manure samples were sampled for nitrogen. phosphorus, potassium, ammonium nitrogen, and percentage dry matter at a cost of $22 per sample. Manure sample delivery to the Land Resource Science Lab was within 2 days after sampling. In the event that the sample delivery was impossible within 2 days the samples were frozen until the delivery date.

4. Letters were sent to the individuals identified as being active in CURB and who may be interested in completing this pilot project. A copy of this letter is provided in the Appendix.

5. Visited interested landowners and took manure sample. At this site visit the handling of manure on the farm was discussed and OMAFRA's Nutrient Management Computer Program was used when possible. Since, the Toshiba T1910 laptop computer was not received until after 55 samples had been taken, the computer program was completed for many landowners at a second site visit.

6. At the site visit the results of the NMANPC were left with the landowners in a printed form as generated with a Citizen PN48 Notebook Printer.

7. When going through the computer program with the landowners any problems that arose and any concerns that they had were documented.

8. A final report of all findings and relevant material was compiled.

MANURE SAMPLING TECHNIQUE

Samples can be taken of solid or liquid manure. The technique for representative manure sampling varies for solid and liquid manure. A representative solid manure sample can be taken two ways. The first way to take a representative solid manure sample is:

- take several samples from different parts of the manure pile and place on a clean area of floor
- samples should be taken as deeply as possible (at least 25 cm)
- mix the samples as thoroughly as possible
- divide the mixed manure into four portions and discard three of these portions
- remix the remaining manure and continue mixing and dividing until the remaining volume of manure is approximately ½ litre
- fill the sampling container three quarters full
- ship or deliver the sample to the laboratory for analysis
  The sample must be delivered to the laboratory within 2 days after sampling
  If the sample can not be delivered within 2 days it should be froze until delivery within two days is possible

The second method to take a solid manure sample is similar in every manner to the first method but instead of taking sub-samples from different parts of the pile sub-samples are taken by taking a sample from every manure spreader load that leaves the storage area. In order to take a representative liquid manure sample:

- the liquid manure tank should be completely agitated before sampling
- several samples should be taken from the tank. Sub-samples taken should be taken at different depths and at different location of the tank, if this can be safely done.
- each subsample should be placed into a clean pail
- once all the sub-samples have been placed in the pail the mixture should be thoroughly mixed
- about a half a litre of the mixed liquid manure should be transferred to the sampling bottle

- ship or deliver the sample to the laboratory for analysis. Like the solid manure sample, liquid samples must be delivered to the laboratory within 2 days of sampling and should be froze until delivery within 2 days if possible

THE NATURE OF LIVESTOCK MANURE

Manure is a valuable nutrient resource, yet livestock manure is often thought of as a waste product of animal production and has not been given the credit it deserves for it's nutrient content. Since the nutrient content of manure has not been accurately known, manure has often been mismanaged as a nutrient source. The possible mismanagement of manure can be caused by improper manure storage or improper application of manure to the land. The mismanagement of manure can cause environmental problems due leaching or surface runoff leaving either the manure storage or the field and causing nutrient and bacterial contamination of watercourses.

Livestock manure consists of the urine and feces produced by livestock as well as any bedding and any contaminated liquids added to the manure in storage such as milkhouse waste. Manure is stored in either the solid, semi-solid or liquid form, yet for ease of handling either the liquid or the solid form is recommended (Agriculture Canada, 1992). Manure, regardless of its form is an excellent nutrient source of the macro-nutrients nitrogen, phosphorous and potassium that are essential for plant growth. Manure is an excellent source of these nutrients since it contains about 75% of the nutrients fed to livestock (Agriculture Canada, 1992). The nutrient value of manure varies due to the size and breed of the animal, feed, bedding, health and age of the animal. Although averages are available for approximation, the only accurate way to obtain the nutrient content of a specific livestock manure system is to take a sample for analysis.

Description of Samples Taken

This pilot project was conducted between May 16, 1994 and September 7,1994. During this time 66 manure samples were taken for 51 landowners, and 11 sample bottles were left with landowners to take their own samples. At the time of the writing of this report analysis results for only the first 60 samples are available and therefore discussion is limited to these 60 samples.

A summary of the manure samples taken is provided in chart form. During the course of the study 66 samples were taken. The total amount of samples accounted for in the following chart does not consider manure from storages that contain manure from more than one type of animal.

LIVESTOCK MANURE SAMPLES TAKEN

	liquid	runoff tank	semi-solid	solid covered manure	solid non-covered manure	non-covered composting manure
dairy	3	7	1	8	18	2
poultry				1	2	
beef				6	1	
swine	2			2		

Please note that sample results are reported on a wet weight basis.

MANURE SAMPLE ANALYSIS RESULTS

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
1	0.52	0.12	0.48	1230	19.65	Solid Pile	Dairy
2	0.32	0.08	0.16	2417	1.70	Liquid	Swine
3	0.30	0.06	0.26	1580	7.23	Liquid	Dairy
4	0.54	0.23	0.71	203	19.82	Solid Composting	Dairy
5	0.06	<0.01	0.13	376	0.74	Runoff Tank	Dairy
6	0.51	0.18	0.67	779	20.13	Solid Pile	Dairy
7	0.40	0.08	0.88	592	18.30	Covered Solid	Dairy
8	0.38	0.12	0.56	295	25.94	Covered Solid	Beef
9	0.57	0.26	0.52	1847	17.37	Solid Pile	Dairy
10	0.02	<.01	0.07	150	0.40	Runoff Tank	Dairy
11	0.48	0.18	0.44	1228	19.51	Solid Pile	Dairy
12	0.73	0.71	0.66	3191	21.98	Covered Solid	Swine

13	0.78	0.67	0.89	2454	25.94	Covered Solid	Swine
14	0.51	0.09	0.97	632	20.83	Solid Pile	Dairy
15	0.03	<.01	0.11	112	0.68	Runoff Tank	Dairy
16	0.50	0.08	0.07	13 98	19.13	Solid Pile	Dairy
17	0.01	<.01	0.04	<50	0.28	Runoff Tank	Dairy
18	0.03	<.01	0.08	115	0.51	Runoff Tank	Dairy
19	0.27	0.05	0.26	147	4.95	Solid Pile	Dairy
20	0.51	0.13	0.44	1832	15.35	Semi-solid	Dairy
21	0.78	0.18	0.77	1981	20.31	Solid Pile	Dairy
22	0.36	0.06	0.64	150	19.73	Covered Solid	Beef/ Swine
23	0.50	0.14	0.38	1697	15.95	Solid Pile	Dairy
24	0.13	0.01	0.21	968	1.26	Runoff Tank	Dairy
25	0.48	0.13	0.58	688	18.90	Solid Pile	Dairy
26	0.03	0.01	0.06	121	0.32	Runoff Tank	Dairy
27	0.28	0.03	0.76	1602	5.87	Covered Solid	Dairy
28	0.73	0.22	0.72	1568	17.72	Liquid	Dairy
29	0.58	0.10	0.48	1023	19.38	Solid Pile	Dairy
30	0.35	0.07	0.50	21	16.19	Solid Pile	Dairy
31	0.70	0.16	0.89	688	26.82	Solid Pile	Dairy
32	0.56	0.18	0.98	121	19.82	Solid Pile	Dairy
33	0.24	0.02	0.18	2075	1.03	Liquid	Swine/beef
34	0.48	0.15	0.58	517	22.05	Solid Pile	Swine/beef
35	0.45	0.16	0.54	870	17.33	Solid Pile	Swine/equine
36	3.35	1.20	1.55	7418	72.19	Solid Pile	Poultry
37	1.51	0.49	0.61	8418	25.98	Solid Pile	Swine/beef
38	0.21	0.04	0.26	1198	2.03	Liquid	Dairy
39	0.53	0.15	0.45	748	16.46	Covered Solid	Dairy
40	0.46	0.15	0.32	3205	16.07	Solid Pile	Dairy
41	0.40	0.09	1.13	1371	25.82	Covered Solid	Beef/poultry/sheep
42	1.02	0.26	0.46	5150	31.49	Covered Solid	Dairy/poultry
43	0.54	0.17	0.60	327	21.13	Solid Pile	Beef
44	1.07	0.36	052	2042	27.03	Covered Solid	Poultry
45	0.48	0.14	0.70	688	20.68	Covered Solid	Dairy
46	0.41	0.10	0.61	308	16.85	Covered Solid	Dairy
47	0.79	0.16	1.25	1382	22.62	Covered Solid	Beef
48	0.14	0.06	0.45	694	20.98	Covered Solid	Beef
49	0.49	0.11	0.58	1090	19.78	Covered Solid	Dairy
50	0.58	0.11	0.86	254	21.62	Covered Solid	Beef
51	0.59	0.16	0.72	28	17.25	Solid Pile	Dairy
52	0.68	0.21	0.53	1467	30.23	Solid Pile	Dairy
53	0.81	0.30	0.39	85	20.58	Solid Composting	Dairy
54	1.38	0.47	0.81	10085	25.71	Covered Solid	Dairy
55	0.63	0.84	0.84	1208	20.20	Solid Pile	Dairy
56	0.72	1.19	1.19	1208	21.54	Covered Solid	Dairy
57	0.74	0.26	0.84	761	25.86	Covered Solid	Beef
58	0.60	0.11	0,86	1510	22.76	Covered Solid	Beef
59	0.57	0.23	0,24	3500	9.80	Liquid	Swine
60	3.80	1.19	1.97	11070	71.45	Solid Pile	Poultry
61	Liquid	Dairy					
62	Solid Pile	Veal With Sawdust Bedding					

63	Solid	Sheep
64	Semi Solid	Dairy
65	Liquid	Swine And Runoff Dairy
67	Liquid Runoff	Swine

SUMMARY OF SAMPLES TAKEN AND LITERATURE COMPARISON

Many of the manure samples taken can be grouped together according to type of manure storage and type of livestock manure stored in the storage. Storages that contained more than one type of livestock manure are not considered in this comparison due to their limited number.

MANURE SAMPLE ANALYSIS SUMMARY

liquid swine

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
2	0.32	0.08	0.16	2417	1.70	Liquid	Swine
59	0.57	0.23	0.24	3500	9.80	Liquid	Swine
average	0.45	0.16	0.20	2959	5.75		

On the basis of 52 samples the Nutrient Management Computer Program shows an average analysis of

average	0.39	0.13	0.18	2824	3.6	Liquid	Swine

The University Of Guelph's results from liquid swine manure analysis show:

	%N	%P	%K	% Moisture	% Dry Matter
average	0.37	0.09	0.15	96.7	3.3
minimum	0.01	0.01	0.01	88.5	11.5
maximum	0.78	0.33	0.49	99.9	0.1

covered solid swine

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
12	0.73	0.71	0.66	3191	21.98	Covered Solid	Swine
13	0.78	0.67	0.89	2454	25.94	Covered Solid	Swine
average	0.76	0.69	0.78	2823	23.96		

The nutrient management computer program has an average analysis result based on 1 sample of:

average	0.56	0.39	0.19	3602	14.9	Solid Manure	Swine

Swine manure in the literature is not differentiated between in regards to whether the manure is a solid manure pile or if it is stored in a covered solid manure storage. Results for solid swine manure analysis at the University of Guelph based on 20 samples show:

	%N	%P	%K	%Moisture	%Dry Matter
Average	0.68	0.33	0.29	71.8	28.2
Minimum	0.13	0.01	0.10	48.7	51.3
Maximum	1.35	0.62	0.75	85.3	14.7

liquid dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
3	0.30	0.06	0.26	1580	7.23	Liquid	Dairy
28	0.73	0.22	0.72	1568	17.72	Liquid	Dairy
38	0.21	0.04	0.26	1198	2.03	Liquid	Dairy
average	0.41	0.11	0.41	1449	8.99		

The nutrient Management Computer Program shows an average liquid dairy manure analysis of:

average	0.26	0.11	0.25	1448	5.2	Liquid	Dairy

The literature results from liquid dairy manure samples from the University of Guelph based on 124 samples show:

	%N	%P	%K	% Moisture	% Dry Matter
Average	0.28	0.06	0.21	92.7	7.3
Minimum	0.04	0.01	0.02	88.1	11.9
Maximum	0.61	0.11	0.58	99.9	0.1

runoff tank dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
5	0.06	<.01	0.13	376	0.74	Runoff Tank	Dairy
10	0.02	<.01	0.07	150	040	Runoff Tank	Dairy
15	0.03	<.01	0.11	112	0.68	Runoff Tank	Dairy
17	0.01	<.01	0.04	<50	0.28	Runoff Tank	Dairy
18	0.03	<.01	0.08	115	0.51	Runoff Tank	Dairy
24	0.13	0.01	0.21	968	1.26	Runoff Tank	Dairy
26	0.03	0.01	0.06	121	0.32	Runoff Tank	Dairy
Average	0.04	0.01	0.10	270	0.60		

covered solid dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
7	0.40	0.08	0.88	592	18.30	Covered Solid	Dairy
27	0.28	0.03	0.76	1602	5.87	Covered Solid	Dairy
39	0.53	0.15	0.45	748	16.46	Covered Solid	Dairy
45	0.48	0.14	0.70	688	20.68	Covered Solid	Dairy
46	0.41	0.10	0.61	308	16.85	Covered Solid	Dairy
49	0.49	0.11	0.58	1090	19.78	Covered Solid	Dairy
54	1.38	0.47	0.81	10085	25.71	Covered Solid	Dairy
56	0.72	1.19	1.19	1208	21.54	Covered Solid	Dairy
average	0.59	0.28	0.75	2040	18.15		

Solid Pile dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
1	0.52	0.12	0.48	1230	19.65	Solid Pile	Dairy
6	0.51	0.18	0.67	779	20.13	Solid Pile	Dairy
9	0.57	0.26	0.52	1847	17.37	Solid Pile	Dairy
11	0.48	0.18	0.44	1228	19.51	Solid Pile	Dairy
14	0.51	0.09	0.97	632	20.83	Solid Pile	Dairy
16	0.50	0.08	0.07	1398	19.13	Solid Pile	Dairy
19	0.27	0.05	0.26	147	14.95	Solid Pile	Dairy
21	0.78	0.18	0.77	1981	20.31	Solid Pile	Dairy
23	0.50	0.14	0.38	1697	15.95	Solid Pile	Dairy
25	0.48	0.13	0.58	688	18.90	Solid Pile	Dairy
29	0.58	0.10	0.48	1023	19.38	Solid Pile	Dairy
30	0.35	0.07	0.50	21	16.19	Solid Pile	Dairy
3I	0.70	0.16	0.89	688	26.82	Solid Pile	Dairy
32	0.56	0.18	0.98	121	19.82	Solid Pile	Dairy
40	0.46	0.15	0.32	3205	16.07	Solid Pile	Dairy
51	0.59	0.16	0.72	28	17.25	Solid Pile	Dairy
52	0.68	0.21	0 .53	1467	30.23	Solid Pile	Dairy
55	0.63	0.84	0.84	1208	20.20	Solid Pile	Dairy
average	0.54	0.18	0.57	1077	19.60		

The Nutrient Management Computer Program shows an average nutrient analysis based on 16 samples of

average	0.54	0.14	0.41	1536	21.4

In the literature dairy manure is not subdivided into dairy solid pile and dairy covered storage but left as one solid manure category. The literature results from 80 manure samples at the University of Guelph for solid dairy manure show:

	%N	%P	%K	% Moisture	% Dry Matter
Average	0.55	0.13	0.44	81.7	18.3
Minimum	0.27	0.05	0.15	66.0	34
Maximum	0.80	0.34	1.44	86.9	13.1

Semi-solid dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid or Liquid	Livestock Type
20	0.51	0.13	0.44	1832	15.35	Semi-solid	Dairy

Solid composting dairy

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid or liquid	Livestock Type
4	0.54	0.23	0.71	203	19.82	Solid Composting	Dairy
53	0.81	0.30	0.39	85	20.58	Solid Composting	Dairy
average	0.68	0.27	0.55	144	20.2		

solid pile poultry

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
36	3.35	1.20	1.55	7418	72.19	Solid Pile	Poultry
60	3.80	1.19	1.97	11070	71.45	Solid Pile	Poultry
average	3.58	1.20	1.76	9244	71.82		

Literature results from the University of Guelph for solid poultry manure, based on 68 samples, show:

	%N	%P	%K	% Moisture	% Dry Matter
average	2.2	0.96	1.06	48.1	51.9
minimum	0.19	0.02	0.09	9.9	90.1
maximum	5.55	2.1	2.3	87.0	13.0

covered solid poultry

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
44	1.07	0.36	0.2	2042	27.03	Covered Solid	Poultry

covered solid beef

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
8	0.38	0.12	0.56	295	25.94	Covered Solid	Beef
47	0.79	0.16	1.25	1382	22.62	Covered Solid	Beef
48	0.14	0.06	0.45	694	20.98	Covered Solid	Beef
50	0.58	0.11	0.86	254	21.62	Covered Solid	Beef
57	0.74	0.26	0.84	761	25.86	Covered Solid	Beef
58	0.60	0.11	0.86	1510	22.76	Covered Solid	Beef
average	0.54	0.14	0.80	816	23.30	Covered Solid	Beef

The literature results from manure analysis do not differentiate between covered solid beef manure storages and solid uncovered beef manure piles:

	%N	%P	%K	% Moisture	% Dry Matter
average	0.58	0.13	0.51	76.6	23.4
minimum	0.21	0.02	0.14	65.0	35.0
maximum	L00	0.28	1.22	87.7	12.3

solid pile beef

Sample Number	N%	P%	K%	NH mg/kg	% Dry Matter	Solid Or Liquid	Livestock Type
43	0.54	0.17	0.60	327	21.13	Solid Pile	Beef

The nutrient Management computer program has no information in its database on solid beef manure.

Please note that all numbers given as from the University of Guelph are cited from the Fact sheet "Manure Characteristics" printed by the Ministry of Agriculture and Food (1985)

COMPARISON OF SOLID NON COVERED AND COVERED SOLID MANURE STORAGE SYSTEMS

The nature of manure is that about 50% of the nitrogen and 75% of the potassium in manure are found in the liquid portion of the manure (Agriculture Canada, 1992). Also, most of the phosphorous is in the solid portion of the manure according to the Best Management Practices for Livestock and Poultry Waste Management (Agriculture Canada, 1994). Another characteristic of manure is that when water additions dilute the nutrient concentrations in the manure.

DAIRY COMPARISON

Eight samples of covered solid dairy manure were analyzed for this project. The average nutrient values are: 0.59% nitrogen, 0.28% phosphorous, 0.75% potassium. 2040 mg/kg of NH_4 and 18.15% Dry Matter. The average values for solid non covered manure piles were based on 18 samples. The average nutrient analysis showed manure with 0.54% nitrogen, 0.18% phosphorous, 0.57% potassium, 1077mg/kg ammonium and 19.60% dry matter.

From these results one can be seen that the nutrient content of covered manure storages is greater than that of the piled (non-covered) manure storages. This difference is due to precipitation diluting nutrients in the non-covered storage as well as the runoff leaving the site carrying away considerable nutrients from the manure pile. Another trend from these results is that covered manure storages tend to have a higher moisture content than do non-covered manure piles. The moisture difference is due to the excess moisture and urine flowing away from the uncovered storage but covered manure storages have walls and or ramps to eliminate the flow of water from the manure. A second reason for the moisture difference is that covered manure storages do not receive as much sunlight and therefore not as much water evaporates from the covered manure storages.

As previously discussed, phosphorous tends to be in the solid portion of manure since phosphorous easily attaches to solid particles. Likewise potassium tends to go into the liquid portion of manure. The Best Management Practices for Livestock and Poultry Waste Management state that 75 percent of potassium is in the liquid portion of manure (Agriculture Canada, 1992). The absorption of the liquid portion of manure by straw limits the liquids ability to flow. With limited flow potassium stays in the manure pile to a greater degree than expected by this 75 percent figure. When looking at the dairy comparison it can be seen that the average phosphorous content of the covered manure is 0.28% and the non-covered piled manure is 0.18%. The potassium differences for the same storages are 0.75% and 0.57% respectively. From this it is easy to see that more potassium leaves the manure pile than does phosphorous. This is due to the removal of nutrients due to liquid movement away from the pile and potassium is more likely to be in the liquid portion of manure than in the solid portion.

BEEF COMPARISON

One sample of solid piled (non-covered) beef manure resulted in an average value of 0.54% nitrogen, 0.17% phosphorous, 0.60% potassium, 327 mg/kg ammonium and 21.13% dry matter.

Six samples of solid covered beef manure were taken with resultant average analysis results of: 0.54% nitrogen, 0.14% phosphorous, 0.80% potassium, 816 mg/kg ammonium and 23.30% dry matter.

The results shown for beef manure do not show the same nutrient trends as evident in the dairy manure. Reasons for this may be that the averages for beef manure are based on only one sample for the solid piled manure and on six samples for the solid covered beef manure. With this limited sample base nutrient trends can not be generated. Although the beef results show that phosphorous and potassium tend to leave manure at different rates (similar to that of the dairy comparisons) it is impossible to determine if this is a trend.

While a nutrient trend for beef manure is not evident a moisture trend is evident. In the covered solid beef manure the moisture content on average is higher than that found in the piled (non-covered) beef manure. As was discussed in the dairy comparison this is due to contaminated liquids not being able to flow away from the storage site and due to decreased evaporation potential from the pile.

POULTRY COMPARISON

For chicken manure our data consists of two solid non-covered manure piles and one covered manure pile. Since the manure nutrient content varies considerably due to management. with this limited amount of solid poultry manure no relevant comparison of averages can be made. The moisture difference between covered and non-covered solid poultry manure shows the same trend as was shown in both the dairy and beef comparisons. As was discussed earlier this is due to decreased evaporation and from liquids being held in the covered manure storage and not allowed to flow away from the manure storage.

Conclusions:

From this comparison it can be concluded that covered solid manure has a higher nutrient content as compared to non-covered solid manure. Covered manure storages allow increased nutrient management efficiencies by minimizing nutrient losses and therefore an increased nutrient content is available for crop production.

MANURE COMPOSTING

Manure can be an excellent source of plant nutrients or it can be an environmental hazard. When properly handled and stored, manure can provide essential nutrients and organic matter to the soil. When improperly stored or applied, nutrients can be lost from manure due to liquid surface runoff, leaching, and volatilization (Agriculture Canada, 1994). The mismanagement of manure can lead to environmental problems due to excessive nutrients and pathogenic organisms entering a biotic system.

Composting may reduce the harmful environmental effects of manure. Manure composting is the decomposition of the organic matter in manure to provide a stable source of plant nutrients. During the composting process the volume of the manure is decreased, nutrients are stabilized. and plant, weed and disease propagules are killed to produce a uniform sterile, odour free and relatively dry product (Ontario Ministry of Agriculture and Food, 1994). Composting can take place by two forms of decomposition, those being anaerobic and aerobic decomposition. Anaerobic decomposition results in byproducts including heat, methane, hydrogen sulfide and carbon dioxide. Aerobic decomposition results in heat, water vapour, carbon dioxide, ammonia and trace amounts of other gases being produced.

Manure samples numbered 51, 52 and 53 were taken at the same farm from three different stages in the composting process. Sample number 52 was of fresh dairy manure, 53 was off partially composted manure and sample 51 was taken from a composting windrow.

The analysis results were as follows:

sample 52 fresh dairy manure:	0.68 %N, 0.21%P, 0.53%K, 1467 mg/kg NH_4-N, 30.23 % dry matter
sample 53 partially decomposed:	0.81%N, 0.30%P, 0.39%K, 85 mg/kg NH_4-N 20.58 % dry matter
sample 54 composting windrow:	0.59%N, 0.16%P, 0.72%K, 28 mg/kg NH_4-N 17.25 % dry matter

A second composting windrow dairy manure sample was taken at a separate farm with the analysis showing: 0.54%N, 0.23%P, 0.71%K, 203 mg/kg NH_4-N and 19.82% dry matter.

Neither of the composting windrow samples were located on a cement pad or had a cover to eliminate rainfall that could lead to surface runoff and leaching. Samples of the fresh and partially decomposed manure were located on a cement pad which eliminates leaching.

In these samples the moisture content increases as the manure composts. One possible reason for this could be that as time goes on more rain will have fallen onto the manure and the manure retains it. A second reason is that water is a by-product of decomposition and therefore as decomposition proceeds the moisture content of the manure may increase. The moisture content of composted manure tends not to runoff since it is tied up in the solid manure and does not exist as a separate liquid.

The most evident trend seen in the three stages of composting is the reduction of the ammonium nitrogen as time goes on. This is due to the stabilization of nitrogen as it is converted to forms more stable than ammonium.

A nutrient trend can not be seen in the three composting manure stages. The reasons we may not be able to attain a nutrient trend are:

- that the manure being compared is not handled consistently throughout decomposition
- increases in nutrients on a percent wet weight basis may be caused partially by the decrease in volume occurring during the composting process
- manure at the different stages of composting was produced at different times of the year and the management of the manure may vary during the year
- the nutrient content of the manure itself may vary during the year due to changes in feed, and herd health
- Since the manure was produced at different times of the year, the weather conditions the manure was exposed to will have varied and this could affect the decomposition as well as the rates of nutrient loss.

From the manure composting samples taken it was evident on site that composting is an excellent method of reducing the volume manure occupies. Theoretically composting manure is also an excellent method of stabilizing nutrients yet conclusions to this regard could not be made from this project due our limited data.

LANDOWNER CONCERNS WITH NUTRIENT MANAGEMENT COMPUTER PILOT PROJECT

The manure nutrient management computer program is an excellent aid for the discussion of nutrient management in the agricultural setting. The program considers current crop needs for nutrients and compares these needs with the nutrients available from previous crops, the nutrients available from previous manure applications, and the nutrients available from fertilizer applications. The goal of this process is to ensure that the crop needs are met in order to achieve a reasonable crop yield without over applying the nutrient applications, since over applying nutrients can lead to environmental degradation. The computer program is very user friendly and easily adaptable to the situations present with different farming practices, yet some concerns do arise when working with it.

One concern evident among landowners was that the program's choices for application of manure included only injected in season, spring incorporation within 1 to 5 days, and not incorporated selections. No fall application or summer spread applications other than injected were available to chose from. On many farms the main spreading of manure occurs after the harvest, since the land is often too wet in the spring for application equipment to be on the land without considerable compaction. According to one landowner a fall incorporated application of manure is very similar to a spring non incorporated; this was agreed to with personal communication by OMAFRA Soil and Crop Advisor Chris Brown (1994). Manure application during the active growth phase of the crop such as in the spring or summer does increase the manure fertilizer efficiency by 30 to 40 percent according to European and Quebec research as reported in the Summer 1994 issue of <u>Sustainable Farming</u> (Cote, 1994.)

Yet another concern is that the program only asked for one previous crop. If the crop grown two years before was an established forage of mainly alfalfa, then even after two years some of the nutrients from the stand will still be available as nutrients are converted from unavailable to available forms.

Concern was shown many individuals that this pilot project included manure samples only and did not include soil samples of the fields with the manure application. It was felt among landowners that both types of samples looked at together would show a more accurate representation of what was actually happening in the fields. Landowners who did not routinely take their own soil samples were left seriously considering doing so in the future and would consider the results an important part of the nutrient management of the farm.

Two landowners brought it to our attention that the computer program attributed nitrogen as the only nutrient available from previous crops. According to the Organic Field Crop Handbook, written by the Canadian Organic Growers, (1992) information is given on the nutrient availability from previous crops. For example in this publication clovers are expected to provide 0.55 to 2% nitrogen, 0.5% phosphorus and 2% potassium (1992).

In the previous crop section of the program the choices available include: established forages under ⅓ legumes, established forages ⅓ to ½ legumes, established forage over ½ legumes and perennial legumes. and crop other than perennial legumes and established forages. Soybeans are a legume but since they are not a perennial legume the selection available in the computer program is crop other than perennial legumes and established forages, yet many landowners feel that soybeans do provide considerable nutrients such as nitrogen from leaves, roots and nodule decay. Landowners who felt that soybeans provided considerable nitrogen were told that this is agreed upon in the United States but in Ontario soybeans are not considered to provide sufficient nitrogen to be relevant.

With implementation of this program into the CURB program one concern is that the limited data base in the number of samples available for reference. The nutrient variability of manure is evident in the Summary of Manure Sample Results and Literature Comparison. The Ministry of Agriculture Food and Rural Affairs is continually adding more samples to it's database and updated versions of the computer program will contain more samples to choose from. Manure analysis results in the database are for storages with only one type of manure only and do not apply to storages with mixed livestock manure. Manure samples are very important for completion of the computer program with individuals who store more than one type of manure together.

Another concern with the database of analysis results is that the database does not differentiate between solid covered storages and solid non-covered storages. As shown previously, the nutrient and moisture content of manure varies considerably depending on the type of manure storage.

Landowners showed concerned with the fertilizer application information in the computer program. The program asks for the application of actual nitrogen, phosphorous and potassium in a starter fertilizer. At no other point in the program does it ask for any other applications of fertilizer such as Urea being applied to corn fields. Other fertilizer additions can be included in the program by adding them to the starter fertilizer. Landowners would prefer a separate listing of the different fertilizer types on the printout. This can be done by saving the file onto a WordPerfect file and typing into the WordPerfect file any necessary changes such as separating starter fertilizer from Urea additions. Doing so adds some time in how long it takes to complete the program but generally landowners feel much better when an accurate printout is received.

A second consideration that landowners felt was overlooked, was that the program accepted fertilizer application in pounds per acre only. Not all manure applications are in pounds per acre since some are applied in gallons per acre. It is possible to convert to pounds per acre from gallons per acre if the fertilizer formulation is known. It would be much easier if the computer could accommodate gallons per acre. One suggestion to this regard is that the computer program have supplementary help screens that have the formulations given for popular liquid fertilizer types. The help screens could aid individuals by providing conversion factors and explanation tables if a part of the computer program is confusing of if an individual requires help in running the computer program (Brown, 1994).

When using the Nutrient Management Computer Program, the program assumes the applications of manure were either solid or liquid but a field may receive both in any given year. Any field may also receive more than one application of either solid or liquid manure such as when manure application occurs before and during active crop growth. The only way to handle two types of nutrient application is to go through each type of manure application separately and saving both into WordPerfect files. Once both files are saved into WordPerfect files, they can be both called up together and information from one copied into the other and the appropriate changes made before a printout is provided to the landowner.

The nutrient management computer program only asks for the manure application rates for the last three years. According to the Summer 1994 issue of Sustainable Agriculture, manure nutrients can remain until the fourth year after application. According to author Denis Cote (1994), "On an annual basis, liquid manure frees 85% of its nitrogen, while solid manure frees only 40% in the first year, 25% the second, 18% the third and 10% the fourth."

The computer program numbers fields numerically from 1 on but some landowners wanted to go through the computer program under different scenarios. When going through different scenarios, it was felt that instead of numbering the fields numerically, labelling them 1A, 1B, 2A, 2B would be beneficial. This is not possible with the program as it is. Changing the numbering of fields involves saving the information onto a WordPerfect file and changing the field numbers in the WordPerfect file before printing a copy for the landowner.

Many landowners of cattle and other livestock types pasture animals. Pastured animals continually add manure additions to a land base. Landowners are interested in determining the nutrient additions to these pasture fields. The only way to determine the volume of manure applied to these fields is to calculate the manure the animals produce in the time frame they are on pasture. Next, the volume of manure produced in the time frame is multiplied by the fraction of time animals are on pasture (not in the barn or barnyard). This method calculates the total manure addition to a pasture field. To determine the application rate the total manure addition should be divided by the area of the pasture. This method of determining the application rate assumes that animals are not selective in the amount of time they spend in different parts of the pasture and that the application of manure is even throughout the field.

The Ontario Ministry of Agriculture, Food and Rural Affair's Nutrient Management Computer Program has the average crop requirements only given for corn and soybeans. This means that users of the program must refer to OMAFRA publication 296 in order to determine the nutrient needs of other crops. The average crop requirements for corn and soybean are very misleading since they do not consider the corn heat units available for growth and therefore may overestimate the nitrogen requirements of the field. The use of averages in the computer program is also misleading since it implies that the field will require that amount of nutrient to be applied regardless of what the nutrient status of the field is from previous management of the field; using Publication 296 will ensure that both factors looked into and not overlooked. When using Publication 296, the figures it gives for nutrient requirements are in kg/ha while the computer program asks for lbs/acre and therefore the numerical values must be converted.

Near the beginning of the computer program, one is asked for the total amount of manure to be handled in a year. The wording of this is misleading since it implies all manure handled is on your farm and not just the manure applied to the farm. Some landowners sell/give manure to their neighbours. The manure sold or given away is handled during the year, as it is produced and taken out of the barn but it may not be spread on the landowner's properly. In the computer program the only way to reduce the volume of manure you have left to spread is to spread it on your fields. The computer program does not allow manure to be sold or left unspread. The only way to deal with manure not spread is to spread it onto an imaginary field, save the program and then go into the WordPerfect file and alter the results to what they should actually say.

LABOUR REQUIREMENTS OF NUTRIENT MANAGEMENT PROJECT

There are two main task requirements of the nutrient management pilot project. The first task is the sampling of the manure. Manure sampling takes approximately a half an hour if a representative sample can be attained by digging in a solid manure pile or by taking dipperfuls of material from an agitated liquid manure tank. If a representative sample can not be achieved in this manner then a sample may be collected by taking a sub-sample from each spreader load or tanker load that leaves the site. This second manner of attaining a manure sample can take numerous hours in order to take a representative manure sample.

The second major task of the nutrient management project is the completion of the nutrient management computer program for each manure sample. The completion of the nutrient management computer program involves looking at each field and determining the nutrient status of the field. The nutrient status is determined from information on the crop being produced, previous crops produced, previous manure applications and current manure and fertilizer applications. The completion of the nutrient management computer program can take a minimum of a half an hour to a maximum of three hours. The large variance in time requirements is due to the number of fields and the size of the farm, as one would expect the smaller the number of fields the less time the program would take to complete.

In total without driving time to get to the site the a nutrient management project would take anywhere from one hour to three and a half hours to complete for each landowner site.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The Nutrient Management Computer Program is an excellent tool for aiding in discussions of nutrient management with landowners. The Nutrient Management Program often leads to further discussions related to nutrient management such as manure composting, organic farming, different cropping techniques, different manure handling techniques, and manure reduction techniques (such as maintenance of water bowls, nozzles and nipples).

2. Landowners are very interested and responsive to this type of program and the information made available during the program.

3. Nutrient availabilities do vary among different types of storages. Covered solid manure storages contain higher nutrient availabilities than do non-covered solid manure storages.

4. A nutrient management project involving site visits for manure sampling and for completion of the nutrient management computer program can take from one hour to three and a half hours to complete.

5. The Nutrient Management Computer Program could easily be implemented into the CURB program. Implementation would involve very little training and would provide to be an excellent aid in promoting nutrient management as a method of preventing environmental degradation.

6. The knowledge requirements, for CURB staff to use the nutrient management computer program, are not extensive since staff are not expected to be crop experts. CURB staff completing the nutrient management program are not required to be soil or crop consultants and as such are not expected to give advice on crop rotations or any other crop related practices. CURB staff completing the computer program only need to understand the terminology used in the program and to be able to discuss the

significance of the program results.

RECOMMENDATIONS

1. It is recommended that if the Manure Management Computer Program is implemented into the Clean Up Rural Beaches Program (CURB) that it be used for the new manure storage system (the one funded by the grant funds) and not the pre-existing system.

2. It is recommended that if the Manure Nutrient Management Computer Program is implemented into to CURB that a workshop is held to ensure that CURB Facilitators understand the terminology, usefulness, and operation of the nutrient management computer program.

3. It is recommended that, prior to a decision being made about the Nutrient Management Computer Program being implemented into CURB, that Ontario Ministry of Agriculture Food and Rural Affairs staff and CURB staff collaborate about tile potential benefits of use, problems that staff may encounter, and concerns that landowners may have.

4. It is recommended that the Nutrient Management Computer Program be implemented into CURB. The reasoning for this recommendation is that we can solve runoff problems in the barnyard with proper manure storages. Yet, surface runoff problem may be created in the field due to manure and fertilizer applications and if this occurs the manure storages erected may just alter the location and the timing of the surface runoff. If surface runoff of manure exists in the field instead of the barnyard then water quality problems will persist.

APPENDIX

Landowners Name
R.R.#2
Town. Ontario
NOG 1W0

June 13, 1994

Dear Person's name:

This year the Ministry of the Environment and Energy and the Grand River Conservation Authority are involved in a nutrient management pilot project. Through the project we are planning to visit landowners who have participated in the CURB program to provide a manure nutrient analysis, free of charge. As a part of the service you will also be provided with a field by field analysis of your current nutrient management program using the Ontario Ministry of the Agriculture and Rural Affairs' newly developed Nutrient Management Computer Program 2. This project is to help us as well as you to understand the nutrient availability in manure and the management of manure. All information collected or discussed will be strictly confidential.

Manure management is an important aspect of farm management since manure provides essential organic matter and nutrients to the soil. The possible reduction of chemical fertilizer inputs through nutrient management has both environmental and economic advantages. Nutrient management should reduce nutrient transport to water courses and provide enough nutrients to produce a realistic crop yield. Most people have the opinion that nutrient management will reduce fertilizer use but this may not always be the case, since the goal of nutrient management is to ensure the proper nutrient balance for crop growth.

Please contact Lori Armstrong at the Grand River Conservation Authority ((519) 621-2761), if you have any questions or wish to be involved in this service. We look forward to meeting with you at a mutually convenient time to discuss nutrient management on your farm.

Yours sincerely,

Lori Armstrong.

SOURCES SITED

Agriculture Canada. 1992. Best Management Practices Livestock and Poultry Waste Management

Agriculture Canada. 1994. Best Management Practices Nutrient Management.

Brown, Christine. 1994. Christine Brown is a Soil and Crop Advisor with the Ontario Ministry of Agriculture and Food. Personal communication on August 24, 1994.

Canadian Organic Growers. 1992. Organic Field Crop Handbook. Appendix E.

Cote, Dennis. 1994. Sustainable Farming. Summer 1994 edition. "Research into fertilizing with manure".pp 6 to 9.

Ministry of Agriculture and Food. 1992, 1993 - 1994 Field Crop Recommendations. Publication 296. Ministry of Agriculture and Food. 1991. Factsheet -Manure Characteristics.

Ontario Ministry of Agriculture and Food. Resources Management Branch. 1994. Agricultural Pollution Control Manual. Chapter J -Manure Processing. pp J-1 to J-17.

Shuyler, Lynn. 1994. Nutrient Management. "Why nutrient management?". Journal of Soil and Water Conservation. pp 3 to 4.