National Exams December 2018

18-Env-B6, Agricultural Waste Management

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an **OPEN** book exam. **Any non-communicating calculator is permitted.**.
3. Answer all 15 questions.
4. Marks are as shown.
5. Use the statistical tables provided.

5 1. Name four steps that can be taken to reduce issues with respect to odour emissions when manure is spread on a farm.

15 2. Develop the recipe for composting a mixture of broiler litter, sawdust and water. Goal is to obtain a C:N ratio of 30:1 and moisture content of 60%.
   a. Use attached Table A-1 from the On-Farm Composting Handbook
   b. Express any concerns with this mixture

10 3. Describe 5 different organic inputs that could be used for on-farm biogas systems. Give pros and cons for each input. Will there be any regulatory issues expected for each input?

5 4. A farmer phones you saying she has noticed manure coming out of her tile outlets. She surfaced applied liquid manure onto the field at normal rates. She is sure at the time of application, it didn't flow off the surface or flow into a catchbasin. What should you tell the farmer?

10 5. Explain the chemical and volume differences between the influent and effluent streams for an anaerobic digester. Explain changes that may be considered in a field nutrient management program to address these differences.

5 6. What are the three key barriers to widespread adoption of biogas systems on Canadian farms?

5 7. When developing the required days of storage for a manure system for a livestock operation what are the considerations?

5 8. Explain engineering involvement that should be required to build a liquid manure storage.

5 9. Detail methods to avoid spills from backflow when pumping liquids through an underground pipe from a lower to higher storage. Specify risks associated with each method.

5 10. Describe the main reason(s) why manure application is a concern for water quality in the Lake Erie basin.

5 11. Answer the following multiple point question.

Why "manure foam" in swine facilities is considered a danger?

a. It contains approximately 60% methane by volume that is suddenly released when the foam is broken down.
b. It contains lethal amounts of Hydrogen Sulphide that is suddenly released when the foam is broken down.
c. It tends to block pit fans reducing or stopping minimum ventilation.
d. All of the above

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12. Using Section C Manure Nutrient Information (attached), fill in the blanks below showing available N, P2O5 and K2O content of solid broiler manure in the year of application. To complete the calculation, assume the following…
    - No lab analysis results are available for the manure generated on this farm
    - The manure is to be spread on Oct 15 and incorporated within 24 hrs of application

    -_____ kg/tonne of N
    -_____ kg/tonne of P2O5
    -_____ kg/tonne of K2O

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13. What gases are commonly produced from decomposing manure? Name two precautionary measures that should be followed to protect workers and livestock from dangerous manure gases. .

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14. A farmer uses a drag hose system to apply manure to his property. He heard that using a large air compressor is effective in cleaning the line. Why could this be very dangerous if not completed in a safe manner.

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15. List 3 acts or regulations that govern the management of manure in Ontario.

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Table A.1
Typical characteristics of selected raw materials (continued)

Material	Type of value	% N (dry weight)	C:N ratio (weight to weight)	Moisture content % (wet weight)	Bulk density (pounds per cubic yard)
Manures					
Broiler litter	Range	1.6–3.9	12–15 [a]	22–46	756–1,026
	Average	2.7	14 [a]	37	864
Cattle	Range	1.5–4.2	11–30	67–87	1,323–1,674
	Average	2.4	19	81	1,458
Dairy tie stall	Typical	2.7	18	79	—
Dairy free stall	Typical	3.7	13	83	—
Horse—general	Range	1.4–2.3	22–50	59–79	1,215–1,620
	Average	1.6	30	72	1,379
Horse—race track	Range	0.8–1.7	29–56	52–67	—
	Average	1.2	41	63	—
Laying hens	Range	4–10	3–10	62–75	1,377–1,620
	Average	8.0	6	69	1,479
Sheep	Range	1.3–3.9	13–20	60–75	—
	Average	2.7	16	69	—
Swine	Range	1.9–4.3	9–19	65–91	—
	Average	3.1	14	80	—
Turkey litter	Average	2.6	16 [a]	26	783

Note: Data was compiled from many references listed in the suggested readings section of this handbook (pages 179–180). Where several values are available, the range and average of the values found in the literature are listed. *These should not be considered as the true ranges or averages, just representative values.*

[a] Estimated from ash or volatile solids data.
[b] Mostly organic nitrogen.

Table A.1
Typical characteristics of selected raw materials (continued)

Material	Type of value	% N (dry weight)	C:N ratio (weight to weight)	Moisture content % (wet weight)	Bulk density (pounds per cubic yard)
Wood and paper					
Bark—hardwoods	Range	0.10–0.41	116–436	—	—
	Average	0.241	223	—	—
Bark—softwoods	Range	0.04–0.39	131–1,285	—	—
	Average	0.14	496	—	—
Corrugated cardboard	Typical	0.10	563	8	259
Lumbermill waste	Typical	0.13	170	—	—
Newsprint	Typical	0.06–0.14	398–852	3–8	195–242
Paper fiber sludge	Typical	—	250	66	1140
Paper mill sludge	Typical	0.56	54	81	—
Paper pulp	Typical	0.59	90	82	1403
Sawdust	Range	0.06–0.8	200–750	19–65	350–450
	Average	0.24	442	39	410
Telephone books	Typical	0.7	772	6	250
Wood chips	Typical	—	—	—	445–620
Wood—hardwoods (chips, shavings, and so on)	Range	0.06–0.11	451–819	—	—
	Average	0.09	560	—	—
Wood—softwoods (chips, shavings, and so on)	Range	0.04–0.23	212–1,313	—	—
	Average	0.09	641	—	—

Note: Data was compiled from many references listed in the suggested readings section of this handbook (pages 179–180). Where several values are available, the range and average of the values found in the literature are listed. *These should not be considered as the true ranges or averages, just representative values.*

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SECTION C Manure Nutrient Information

Calculate the **available** P_2O_5 and K_2O. (Some labs may already have done these calculations). If a manure analysis is not available, use the values in Table 3, page 9. The *Nutrient Management Act* requires manure nutrient testing.

The following conversions may be required:

Convert to METRIC				Convert to IMPERIAL			
%	kg/1,000 L	multiply by	10	%	lb per 1,000 gallons	multiply by	100
%	kg/tonne	multiply by	10	%	lb per ton	multiply by	20
mg/L	%	divide by	10,000	ppm	%	divide by	10,000

Available P_2O_5:

Percent P _____ X 0.92 = _____ % available P_2O_5

(From Table 3, page 9, or Lab Analysis)

X 10 = _____ kg/1,000 L
X 10 = _____ kg/tonne
X 100 = _____ lb/1,000 gal
X 20 = _____ lb/ton

Calculate only the one that you need.

Available K_2O:

Percent K _____ X 1.08 = _____ % available K_2O

(From Table 3, page 9, or Lab Analysis)

X 10 = _____ kg/1,000 L
X 10 = _____ kg/tonne
X 100 = _____ lb/1,000 gal
X 20 = _____ lb/ton

Calculate only the one that you need.

Example

A farmer took a liquid hog manure sample, which came back with the analysis of 0.3% N, 0.1% P, 0.2% K, and 1,000 ppm NH_4-N (0.1%). He will incorporate the manure within 3 days.

N *Availability depends on additional factors. See Method 1 or 2 on the following pages.*

P_2O_5 *0.1 X 0.92 = 0.092% = 9.2 lb/1,000 gal*

K_2O *0.2 X 1.08 = 0.216% = 21.6 lb/1,000 gal*

Use Method 1 or 2 to calculate available nitrogen.

Method 1 should be used where there is no manure analysis available and/or where manure is "Late Summer" or "Fall" applied (with Lab Analysis).

Method 2 should be used for "Spring, Pre-plant or Side-dress" applied manure with Lab Analysis.

METHOD 1: Available Nitrogen (For Fall Applied Manure and/or Using Nutrient Averages)

Where manure is being fall applied, use the total percent nitrogen from the analysis and determine available N (using Table 4, page 10). Where a manure analysis is not available, use the numbers in the typical analysis chart (Table 3). .

Available N:

% Total N (Table 3 or Lab Analysis)	X	Available N (Table 4, page 10)	=		
_____	X	_____	=	_____ %	

	_____	kg/1,000 L
X 10 =	_____	kg/tonne
X 100 =	_____	lb/1,000 gal
X 20 =	_____	lb/ton

Calculate only the one that you need.

Table 3: Typical Manure Analysis by Livestock Type

Type of Manure	% Dry Matter	% Total Nitrogen	% Organic N[3]	% P	% K
Liquid Manure					
Beef[2]	6.0	.28	.13	.08	.18
Dairy – outside storage[2]	6.0	.30	.14	.07	.23
Dairy – under barn storage[1]	8.0	.41	.20	.09	.29
Dairy heifers	11.0	.55	.30	.13	.32
Poultry layers	10.0	.74	.22	.26	.30
Swine – sows / weaners	3.0	.35	.11	.10	.15
Swine – finishers	5.0	.49	.19	.16	.20
Swine finishers – wet/dry feeders	6.5	.58	.23	.20	.24
Liquid Runoff	1.0	.10	.04	.02	.12
Liquid Biosolids – anaerobic	4.4	.28	.19	.14	0.00
Milk-fed Veal	1.5	.08	.24	.02	.18
Solid Manure					
Beef	25.0	.72	.64	.25	.59
Dairy	20.0	.55	.42	.16	.47
Poultry – layers	20.0	1.15	.51	.51	.43
Poultry – broilers	> 50.0	2.73	2.30	1.30	1.45
Sheep	30.0	1.06	.61	.59	.70
Horses	50.0	.32	.28	.26	.61

Source: NMAN Databank

[1] assumes milkhouse wastes are stored with manure

[2] Includes some yard runoff

[3] Ammonium Nitrogen (%) can be calculated by subtracting Organic N from Total N.

Table 4: Available Nitrogen (as a Proportion of Total Nitrogen[2])

Application Time	Incorporated (< 24 hours)					Not Incorporated[3]					
	Late Summer	EarlyFall	Late Fall	Pre-plant[1]	Side-dress[1]	Late Summer	Early Fall	Late Fall	Pre-plant[1] Bare Soil	Pre-plant[1] Residue	Side-dress[1]
Urea (commercial N)	.10	.20	.50	.95	1.00	—	.10	.40	.85	.75	.85
Solid Cattle/Sheep	.27	.26	.30	.34	.34	.26	.24	.24	.23	.27	.26
Solid Swine	.34	.34	.34	.38	.36	.34	.32	.28	.27	.30	.33
Solid Poultry – Layers	.28	.35	.45	.52	.65	.25	.30	.35	.32	.40	.48
Solid Poultry – Pullets	.33	.37	.39	.43	.48	.31	.34	.33	.31	.36	.41
Solid Poultry – Broilers	.36	.39	.35	.38	.37	.35	.37	.32	.31	.33	.36
Liquid Cattle	.29	.36	.41	.44	.54	.27	.31	.32	.26	.34	.41
Liquid Swine	.23	.33	.48	.56	.70	.20	.27	.35	.29	.40	.50
Liquid Poultry	.26	.33	.51	.62	.78	.22	.26	.39	.33	.44	.55
Liquid Biosolids	.33	.37	.42	.43	.48	.32	.34	.36	.31	.36	.40

Source: Adapted from Barry, Beauchamp et. al., U. of Guelph 2000

[1] assumes a spring planted crop; Side-dress refers to application to a growing crop

[2] accounts for ammonia loss to atmosphere and mineralization of organic N

[3] for manure incorporated within 3 days use: (incorporated value + non incorporated value) ÷ 2

Late Summer = up to Sept. 20

Early Fall = Sept. 21 to Nov. 9

Late Fall = Nov. 10 to Winter

The NMAN software uses a more detailed method of determining available nitrogen. For different incorporation periods, NMAN will provide more precise estimates of available nitrogen.

Where a cover crop (i.e. clover, rye, oats or barley) is utilized, and manure is applied in late summer or fall, use the "Late Fall" column in Table 4 to determine the Available Nitrogen for the next crop.

Where manure is applied in late summer or early fall (following the harvest of a crop), on a soil in the Hydrologic Group AA, or A, or in late summer on a soil in the B Hydrologic Group, without a cover crop, the Nitrogen Index (SECTION O) must be completed.

Example

A farmer has liquid hog manure from a finishing barn. He does not have wet/dry feeders. He plans to apply the manure in late April and plans to incorporate his manure within 24 hours. Since a manure test is not available he uses a typical analysis from Table 3, page 9, and using Table 4, calculates the available N, P_2O_5 and K_2O. He finds his manure to have the following nutrients available for the next growing season.

Available N:

0.49 % (Manure Analysis, Table 3, page 9) X 0.56 (Available N factor) X 100 = ***27.4*** *lb/1,000 gal*