# APPENDIX I

## A Method to Determine Manure Application Rates
## (Adapted from MWPS-18, Livestock Waste Facilities Handbook)

* Please note this methodology takes into account residual nitrogen in the soil from manure applications for the three previous years.

---

### Section A. Manure Composition and Soil Information

1. Manure composition:

   a. Values from chemical analysis of manure.

| Composition | | Your Farm |
|---|---|---|
| Laboratory data are often given in ppm. To convert ppm to percent, divide by 10,000. If composition data are not available, use Table I.1 or I.2. | Total N<br>Ammonium N<br>Nitrate N<br>$P_2O_5$<br>$K_2O$ | _____%<br>_____%<br>_____%<br>_____%<br>_____% |

   b. Determine the amount of each nutrient per ton of solid manure or per 1,000 gal. of liquid manure. If nutrient contents are given in percent:

   - % nutrient in manure x 20 = lb nutrients/ton; or,
   - % nutrient in manure x 100 = lb nutrients/1,000 gal. (e.g., 0.5% Total N = 10 lb/ton or 42.5 lb/1,000 gal.).

| Composition | Example (Table I.2) | Your Farm |
|---|---|---|
| Total N | 36 lb/ 1,000 gal. | _____ lb/ ____ |
| Ammonium N* | 26 lb/ 1,000 gal. | _____ lb/ ____ |
| Nitrate N* | -- lb/ 1,000 gal. | _____ lb/ ____ |
| $P_2O_5$ | 27 lb/ 1,000 gal. | _____ lb/ ____ |
| $K_2O$ | 22 lb/ 1,000 gal. | _____ lb/ ____ |

* If only total N is determined, assume 50% ammonium N and 5% nitrate N.

2. Soil information:

| Soil Information | Example | Your Soil |
|---|---|---|
| Texture | Sandy loam | |
| Soil pH | 6.2 | |
| Available P | - lb/acre | lb/acre |
| Exchangeable K | - lb/acre | lb/acre |

**Section B. Nutrient Needs of Crop**

| | Example | Your Crop |
|---|---|---|
| Crop to be grown | Timothy | |
| Expected yield/acre | 2.5 T | |
| Nutrients required/acre | N = 100 lb/acre | lb/acre |
| (based on soil test report or | $P_2O_5$ = 55 lb/acre | lb/acre |
| Table I.4) | $K_2O$ = 55 lb/acre | lb/acre |

**Section C. Annual Rate of Manure Application**

**1. Calculate amount of organic N in manure (either per ton or per 1,000 gal):**

lb total N - (lb ammonium N + lb nitrate N) = lb organic N

Example:

36 - (26 + - ) = 10 lb organic N/1,000 gal.

Your manure:

_____ - (_____ + - ) = _____ lb organic N/_____

**2. Calculate amount of organic N in manure made available the first year.**

lb organic N/(ton or 1,000 gal) x mineralization factor (Table I.3) =
lb available organic N/(ton or 1,000 gal)

Example:

10 x 0.35 + 3.5 lb available organic N/ 1,000 gal.

Your farm:

_____ x _____ = _____ lb available organic N/_____

**3. Calculate amount of plant-available N in manure (use either a or b below).**

a. Incorporated application of manure (assume 25% of ammonium N is lost by volatization if knifed-in; assume no loss if immediately incorporated by other methods):

Available organic N (sec C.2) + [Ammonium N (Sec A.1.b) x 0.75] + Nitrate N (Sec A.1.b) = lb plant - available N/(ton or 1,000 gal)

Example:

__3.5__ + [__26__ x 0.75] + __-__ = __23__ lb available N/1,000 gal.

Your farm:

_____ + [_____ x 0.75] + _____ = _____ lb available N/_____

b. Surface application of manure (assumes 50% of ammonium N is lost by ammonia volatilization):

Available organic N (Sec C.2) + [Ammonium N (Sec A.1.b) x 0.50] + Nitrate N (Sec A.1.b) = lb plant-available N/(ton or 1,000 gal)

Your farm:

_____ + [_____ x 0.50] + _____ = _____ lb available N/_____

**4. Adjust N fertilizer recommendation to account for residual N from manure applications in the last 3 years.**

a. Manure applied to field 1 year ago (if none, proceed to b):

lb organic N/(ton or 1,000 gal) of manure x (mineralization factor x 0.50) x tons or 1,000 gals applied/acre = lb residual N/acre

Example:

10 lb/1,000 gal x (0.35 x 0.50) x 6,000=10.5 lb residual N/acre

Your farm:

_____ x (_____ x 0.50) x _____=_____ lb residual N/acre

b. Manure applied to field 2 years ago (if none, proceed to c.):

lb organic N/(ton or 1,000 gal) or manure x (mineralization factor x 0.25) x tons

or 1,000 gal applied/acre = lb residual N/acre

Your farm:
_____ x (_____ x 0.25) x _____=_____ lb residual N/acre

c. Manure applied 3 years ago (if none, proceed to d.):

lb N/(ton or 1,000 gal) of manure x (mineralization factor x 0.125) x tons or 1,000 gal applied/acre = lb residual N/acre

Your farm:

_____ x (____ x 0.125) x _____ =_____ lb residual N/acre

d. Total residual N:

Sec C.4.a + Sec C.4.b + Sec C.4.c = total lb residual N/acre

Example:

_10.5_ + _-_ + _-_ =10.5 total lb residual N/acre

Your farm:

_____+_____ +____=____ total lb residual N/acre

e. Adjust N requirement of crop:

lb N required by crop (Sec B) - lb residual N (Sec C.4.d) = lb N required/acre

Example:

_100_ - _10.5_ = _89.5_ lb N required/acre

Your farm:

____ - ____ =____lb N required/acre

**5. Annual manure applications based on amount of N required by crop:**

Adjusted N required (Sec C.4.e) ÷ lb available N/(ton or 1,000 gal) (Sec C.3.a or C.3.b) = tons of manure/acre or number of 1,000 gal units of manure/acre

Example:

_89.5_ ÷ _23_ = _3.891_ tons of manure/ac or 1,000 gal units of manure/ac

Your farm:

____ ÷ ____ = ____ tons of manure/ac or 1,000 gal units of manure/ac

**6. Annual manure application based on amount of $P_2O_5$ required by crop:**

$P_2O_5$ required by crop (Sec B) ÷ lb $P_2O_5$/(ton or 1,000 gal) (Sec A.1.b) = tons manure/acre or number of 1,000 gal units of manure/acre

Example:

_55_ ÷ _27/lb/1,000 gal_ = _2.037_ tons of manure/ac or 1,000 gal units of manure/ac

Your farm:

____ ÷ ____ = ____tons of manure/ac or 1,000 gal units of manure/ac

**7. Select annual rate of manure to be applied. If manure is to supply all N and $P_2O_5$ needs of the crop, select the HIGHER of the two values (Sec C.5 or Sec C.6) as your application rate per acre. If your aim is to maximize use of nutrients in animal manure, select the LOWER of the two values, then supplement with commercial fertilizer to supply the remainder of the nutrients required by the crop.**

Rate of manure to be applied is:

Example:

_2.037_ tons of manure/acre

Your farm:

_____ tons of manure/acre

**Section D. Additional Fertilizer Required**

**1. Nitrogen (do not complete if manure rate selected in Sec C.7 supplies all of the required N).**

a. Available N added in manure:

Tons or 1,000 gal units of manure added/acre (Sec C.7) x lb available N/(ton or 1,000 gal) (Sec C.3.a or C.3.b) = lb available N applied

Example:

_2.037_ x _23 lb/1,000 gal_ = _46.9 lb_ available N applied

Your farm:

_____ x _____ = _____ available N applied

b. Additional fertilizer N required:

Adjusted N requirement (Sec C.4.e) - lb N applied (D.1.a) = lb fertilizer N required

Example:

_89.5_ - _46.9_ = _42.6_ lb fertilizer N

Your farm:

_____ - _____ = _____ lb fertilizer N

**2. Phosphorus (do not complete if manure rate selected in Sec C.7 supplies all of the required amount of $P_2O_5$ added in manure):**

Tons or 1,000 gal units of manure/acre (Sec C.7) x lb $P_2O_5$/(ton or 1,000 gal) (Sec A.1.b) = lb $P_2O_5$ applied

Your farm:

_____ x _____ = _____ lb $P_2O_5$ applied

b. Additional fertilizer $P_2O_5$ required:

$P_2O_5$ required by crop (Sec B) – lb $P_2O_5$ applied (Sec D.2.a) = lb fertilizer $P_2O_5$ required

Your farm:

_____ – _____ = _____ lb fertilizer $P_2O_5$ required

**3. Potassium:**

a. $K_2O$ added in manure:

Tons or 1,000 gal units of manure/acre (Sec C.7) x lb $K_2O$/(ton or 1,000 gal) (Sec A.1.b) = lb $K_2O$ applied

Example:

_2.037_ x _22 lb/1,000_ = _44.8_ lb $K_2O$ added

Your farm:

_____ x _____ = ____ lb $K_2O$ added

b. Additional $K_2O$ required:

$K_2O$ required by crop (Sec B) - lb $K_2O$ applied (Sec D.3.a) = lb fertilizer $K_2O$ required

Example:

_250_ - _44.8_ = _205.2_ lb fertilizer $K_2O$ required

Your farm:

_____ - _____ = _____ lb fertilizer $K_2O$ required

**TABLE I.1**

**Nutrients in Solid Manure at the Time of Land Application**

| Species | Bedding or litter | Dry matter | Ammonium N | Total N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|---|
| | | % | lb/ton manure | | | |
| Swine | No | 18 | 65 | 108 | 97 | 87 |
| | Yes | 18 | | | | |
| Beef | No | 15 * | 4 | 11 | 7 | 10 |
| | No | 52+ | 7 | 21 | 14 | 23 |
| | Yes | 50 | 8 | 21 | 18 | 26 |
| Dairy | No | 18 | 4 | 9 | 4 | 10 |
| | Yes | 21 | 5 | 9 | 4 | 10 |
| Sheep | No | 28 | 5 | 18 | 11 | 26 |
| | Yes | 28 | 5 | 14 | 9 | 25 |
| Horse | Yes | 46 | 4 | 14 | 4 | 14 |

Note:

* Open concrete lot.
+ Open dirt lot.

Source: MWPS-18, Livestock Waste Facilities Handbook.

**TABLE I.2**

**Nutrients In Liquid Manure at the Time of Land Application**

| Species | Waste handling | Dry matter | Ammonium N | Total N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|---|
| | | % | lb/1,000 gal manure | | | |
| Swine | Liquid pit | 4 | 26 | 36 | 27 | 22 |
| | Lagoon * | 1 | 3 | 4 | 2 | 4 |
| Beef | Liquid pit | 11 | 24 | 40 | 27 | 34 |
| | Lagoon * | 1 | 2 | 4 | 9 | 5 |
| Dairy | Liquid pit | 8 | 12 | 24 | 18 | 29 |
| | Lagoon * | 1 | 2.5 | 4 | 4 | 5 |
| Vealcalf | Liquid pit | 3 | 19 | 24 | 25 | 51 |

Source: MWPS-18. Livestock Waste Facilities Handbook.

* Includes lot runoff water.

**TABLE L3**

**Amount of Nitrogen Mineralized or Released From Organic Nitrogen Forms in Manure to Plant Available Forms During the Growing Season**

| Manure Type | Manure Handling | Mineralization Factor |
|---|---|---|
| Swine | Fresh | 0.50 |
| | Anaerobic liquid | 0.35 |
| | Aerobic liquid | 0.30 |
| Beef | Solid without bedding | 0.35 |
| | Solid with bedding | 0.25 |
| | Anaerobic liquid | 0.30 |
| | Aerobic liquid | 0.25 |
| Dairy | Solid without bedding | 0.35 |
| | Solid with bedding | 0.25 |
| | Anaerobic liquid | 0.30 |
| | Aerobic liquid | 0.25 |
| Sheep | Solid | 0.25 |
| Horses | Solid with bedding | 0.20 |

**TABLE L4**

**Estimated Removal of Plant Nutrients By Various Crops**

| Crop | D.M. Yield (t/ha) | Kilograms per hectare | | | | |
|---|---|---|---|---|---|---|
| | | Nitrogen N | Phosphorus $P_2O_5$ | Potassium $K_2O$ | Calcium Ca | Magnesium Mg |
| Oat Grain | 3.1 | 56 | 22 | 17 | 3 | 4 |
| Oat Straw | 4.5 | 28 | 11 | 67 | 9 | 10 |
| Barley Grain | 3.2 | 56 | 28 | 17 | 2 | 3 |
| Barley Straw | 3.4 | 22 | 11 | 50 | 13 | 3 |
| Wheat Grain | 2.7 | 56 | 28 | 17 | 1 | 7 |
| Wheat Straw | 3.4 | 22 | 5 | 39 | 7 | 3 |
| Corn Silage | 12.3 | 112 | 56 | 151 | 12 | 21 |
| Alfalfa Hay | 8.9 | 213 | 50 | 275 | 132 | 27 |
| Timothy Hay | 8.9 | 151 | 39 | 163 | 20 | 11 |
| Red Clover Hay | 8.9 | 168 | 39 | 179 | 121 | 29 |

Source: Atlantic Provinces Field Crop Guide.