Appendix A. Blending Sample Calculation

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Appendix A_1

Symbols

a	=	total weight of ingredient a
b	=	total weight of ingredient b
c	=	total weight of ingredient c
M	=	desired mix moisture content
Ma, Mb, Mc…	=	moisture content of ingredients a, b, c
%Ca, %Cb, %Cc…	=	% carbon of ingredients a, b, c… (on dry weight basis)
%Na, %Nb, %Nc…	=	% nitrogen of ingredients a, b, c,… (on dry weight basis)
R	=	desired C:N ratio of mix
Ra, Rb	=	C:N ratio of ingredients a, b, c

Appendix A_2

Formulas for Only Two Ingredients

Required amount of ingredient a per kg b

To obtain desired C:N raio: $$a = \frac{\%\,Nb}{\%\,Na} \times \frac{(R-Rb)}{(Ra-R)} \times \frac{(1-Mb)}{(1-Ma)}$$

To obtain desired moisture content: $$a = \frac{Mb-M}{M-Ma}$$

Appendix A_3

Formulas for a Mix of Materials

C:N ratio $$= \frac{\text{weight of C in ingredient a + weight of C in b + weight of C in c +…}}{\text{weight of N in a + weight of N in b + weight of N in c +…}}$$

$$= \frac{[\%Ca \times a \times (1-Ma)] + [\%Cb \times b \times (1-Mb)] + [\%Cc \times c \times (1-Mc)]}{[\%Na \times a \times (1-Ma)] + [\%Nb \times b \times (1-Mb)] + [\%Nc \times c \times (1-Mc)]}$$

Moisture content $$= \frac{\text{weight of water in ingredient a + weight of water in b + weight in water in c + ...}}{\text{total weight of all ingredients}}$$

$$= \frac{(a \times Ma) + (b \times Mb) + (c \times Mc) \ldots}{a + b + c + ...0}$$

Example

Assume a broiler breeder farm has manure to compost and that sawdust will be used as a bulking agent. How much sawdust and water needs to be added to the manure to have a good compost mix?

Step 1. Determine the approximate nitrogen, carbon, moisture, and bulk density from Table 3 in Chapter 2.

Material	Nitrogen (dry weight) (%)	C:N (dry weight)	Moisture Content (%)	Bulk Density @ Moisture Content (kg/m^3)
Broiler Breeder Manure	3.60	10	46	470
Sawdust	0.06 - 0.80	200 - 750	19 - 65	350 - 450

Note: For a range of numbers, take the average if there has been no analysis performed.

Sawdust	0.43	475	42	400

Step 2. Using the formula for two ingredients from Table 3, determine the amount of sawdust (a) needed for each kg of manure, (b) to give a desired C:N ratio (R) of 30.

Given:

b = 1 kg of broiler breeder manure
Ma = 0.20 (20% moisture content of sawdust)
Mb = 0.46 (46% moisture content of manure)
Ra = 500 (C:N ratio of sawdust)
Rb = 10 (C:N ratio of manure)
%Na = 0.1 (% nitrogen in sawdust)
%Nb = 3.6 (% nitrogen in manure)

Determine: a (weight of sawdust needed) for the desired C:N ratio of R = 30 (Appendix A_2)

$$a = \frac{\%Nb}{\%Na} \times \frac{(R-Rb)}{(Ra-R)} \times \frac{(1-Mb)}{(1-Ma)}$$

Calculation:

$$a = \frac{3.6}{0.1} \times \frac{(30-10)}{(500-30)} \times \frac{(1-0.46)}{(1-0.20)} = 1.0$$

Answer: For each kg of manure, add 1.0 kg of sawdust to obtain a C:N ratio of 30.

Step 3. Check the mix moisture content (M.C.) using the moisture content formula in Appendix A_2.

Given:

a = 1.0 kg weight of sawdust from Step 2
b = 1.0 kg weight of manure
Ma = 0.20 (20% moisture content of sawdust)
Mb = 0.46 (46% moisture content of manure)

Determine: M.C. (mix moisture content) (Appendix A_3)

$$M.C. = \frac{(a \times Ma) + (b \times Mb)}{a + b}$$

Calculation: M.C. = $\frac{(1 \times 0.20) + (1 \times 0.46)}{1 + 1}$ = 0.33 or 33 %

Answer: This starting moisture content of 33% is too low, since ideal moisture content runs from 50 to 60%.

Step 4. Adjust moisture content to 55% using the two ingredient formula from Appendix A_2.

Given:
b = 1 kg of manure/sawdust mix
M = 0.55 (55% desired moisture content)
Ma = 1.0 (100% moisture content of water)
Mb = 0.33 (33% moisture content of manure/sawdust mix)

Determine: 'a' quantity of water required

$$a = \frac{Mb - M}{M - Ma}$$

Calculation: $a = \frac{0.33 - 0.55}{0.55 - 1.00} = 0.49$

Answer: Add 0.49 kg of water for every 1.0 kg of manure/sawdust mix.

Step 5. Determine how much manure, sawdust and water to mix.

Given:
Tractor bucket volume = 2.0 m^3
Manure bulk density = 470 kg/m^3
Sawdust bulk density = 350 kg/m^3

Determine: Volume of manure, sawdust, and water

Calculation: One bucket of manure weighs 2.0 m^3 x 470 kg/m^3 = 940 kg

Since an equal weight of manure and sawdust is wanted, add 940 kg of sawdust or 940 kg / 350 kg/m^3 = 2.7 m^3 of sawdust

This is equal to 2.7 m^3 / 2.0 m^3 per bucket = 1.35 buckets of sawdust

For each bucket of manure used, there will be a total manure/sawdust mix weighing 940 kg + 940 kg = 1840 kg

Similarly, for each bucket of manure used, add:
0.49 kg of manure / kg of mix x 1840 kg = 902 kg of water (902 L of water)

Answer: For each bucket of manure, add 1.35 buckets of sawdust and 902 litres of water.

Worksheet

Step 1. Determine the approximate nitrogen, carbon, moisture, and bulk density from Table 3 in Chapter 2.

Material	Nitrogen (dry weight) (%)	C:N (dry weight)	Moisture Content (%)	Bulk Density @ Moisture Content (kg/m^3)

Note: For a range of numbers, take the average if there has been no analysis performed.

Step 2. Using the formula for two ingredients from Table 3, determine the amount of sawdust (a) needed for each kg of manure, (b) to give a desired C:N ratio (R) of 30.

Given:

b = _____ kg of broiler breeder manure
Ma = _____ % (moisture content of sawdust)
Mb = _____ % (moisture content of manure)
Ra = _____ (C:N ratio of sawdust)
Rb = _____ (C:N ratio of manure)
%Na = _____ (% nitrogen in sawdust)
%Nb = _____ (% nitrogen in manure)

Determine: a (weight of sawdust needed) for the desired C:N ratio of R = 30

$$a = \frac{\%Nb}{\%Na} \times \frac{(R-Rb)}{(Ra-R)} \times \frac{(1-Mb)}{(1-Ma)}$$

Calculation: a = _____ x _____ x _____ = _____%

Step 3. Check the mix moisture content (M.C.) using the moisture content formula in Appendix A_2.

Given:

a = _____ kg weight of sawdust from Step 2
b = _____ kg weight of manure
Ma = _____ % (moisture content of sawdust)
Mb = _____ % (moisture content of manure)

Determine: M.C. (mix moisture content)

$$M.C. = \frac{(a \times Ma) + (b \times Mb)}{a + b}$$

Calculation: M.C. = _____ + _____ / _____ = _____%

Step 4. Adjust moisture content to 55% using the two ingredient formula from Appendix A_2.

Given:
b = _____ kg of manure/sawdust mix
M = _____ % (desired moisture content)
Ma = _____ % (moisture content of water)
Mb = _____ % (moisture content of manure/sawdust mix)

Determine: 'a' quantity of water required

$$a = \frac{Mb - M}{M - Ma}$$

Calculation: a = _____ L

Step 5. Determine how much manure, sawdust and water to mix.

Given:
Tractor bucket volume = _____ m^3
Manure bulk density = _____ kg/m^3
Sawdust bulk density = _____ kg/m^3

Determine: Volume of manure, sawdust, and water

Calculation: One bucket of manure weighs _____ kg

Since an equal weight of manure and sawdust is wanted, add_____ kg of sawdust or _____ kg /_____ kg/m^3 = _____ m^3 of sawdust

This is equal to _____ m^3 / _____ m^3 per bucket = _____ buckets of sawdust.

For each bucket full of manure used, there will be a total manure/sawdust mix weighing _____kg +_____ kg =_____ kg

Similarly, for each bucket of manure used, add:
_____ kg of manure / kg of mix x _____ kg =_____ kg water
(_____ L of water)

These calculations can be done automatically by using the AAFRD manure composting calculator. The link for this calculator is:

http://www.agric.gov.ab.ca/app19/calc/manure/manure.jsp