

Formulas for Determining Compost Recipes (NRAES publication, pages 18-20)

Formulas for an individual ingredient

Moisture content	=	% moisture content ÷ 100
Weight of water	=	total weight * moisture content
Dry weight	=	total weight - weight of water
	=	total weight * (1 - moisture content)
Nitrogen content	=	dry weight * (% N ÷ 100)
	=	C content ÷ C:N ratio
Carbon content	=	dry weight * (% C ÷ 100)
	=	N content * C:N ratio
% carbon	=	% N x C:N ratio
% nitrogen	=	% C ÷ C:N ratio

Convert C and N from “dry” to “as is” basis

(C or N, % dry basis) * (1 - moisture content)

(C or N, % dry basis) * (solids content)

General formulas for a mix of materials

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

$$= \frac{(a * m_a) + (b * m_b) + (c * m_c) + \dots}{a + b + c + \dots}$$

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

$$= \frac{[\% C_a * a * (1 - m_a)] + [\% C_b * b * (1 - m_b)] + \dots}{[\% N_a * a * (1 - m_a)] + [\% N_b * b * (1 - m_b)] + \dots}$$

Symbols

a	=	total weight of ingredient a
b	=	total weight of ingredient b
c	=	total weight of ingredient c
m _a , m _b , ...	=	moisture content of ingredients a, b, ...
% N _a , N _b , ...	=	% nitrogen of ingredients a, b, ... (% of dry weight)
% C _a , C _b , ...	=	% carbon of ingredients a, b, ... (% of dry weight)

Shortcut formulas for only two ingredients (e.g., biosolids plus woodchips)

1. Required amount of ingredient a per pound of b based on the desired moisture content:

$$a = \frac{m_b - M}{M - m_a}$$

The check the C:N ratio using the general formula.

2. Required amount of ingredient a per pound of b based on the desired C:N ratio:

$$a = \frac{\% N_b}{\% N_a} \times \frac{(R - R_b)}{(R_a - R)} \times \frac{(1 - m_b)}{(1 - m_a)}$$

Then check the moisture content using the general formula.

Symbols

a	=	pounds of ingredient a per pound of ingredient b
M	=	desired mix moisture content
m_a	=	moisture content of ingredient a
m_b	=	moisture content of ingredient b
R	=	desired C:N ratio of the mix
R_a	=	C:N ratio of ingredient a
R_b	=	C:N ratio of ingredient b

Sample Calculation: Recipe proportions, moisture content, and C:N ratio

Calculate an appropriate recipe for a mix of biosolids and woodchips having the following composition:

Biosolids: moisture = 80%, C:N = 10:1, N = 4.2% (dry weight)

Woodchips: moisture = 25%, C:N = 560:1, N = 0.09% (dry weight)

Blending materials to the desired moisture content

Weight of water = total weight * moisture content

Weight of dry matter = total weight - weight of water

Weight of nitrogen (N) = weight of dry matter * (%N ÷ 100)

Weight of carbon (C) = C:N ratio * weight of N

1 pound biosolids contains:

$$\begin{aligned} \text{Water} & 1 \text{ pound} * 0.80 & = & 0.80 \text{ lbs} \\ \text{Dry matter} & 1 \text{ pound} - 0.80 & = & 0.20 \text{ lbs} \\ \text{N} & 0.20 * 0.042 & = & 0.0084 \text{ lbs} \\ \text{C} & 10 * 0.0084 & = & 0.084 \text{ lbs} \end{aligned}$$

1 pound woodchips contains:

$$\begin{aligned} \text{Water} & 1 \text{ pound} * 0.25 & = & 0.25 \text{ lbs} \\ \text{Dry matter} & 1 \text{ pound} - 0.25 & = & 0.75 \text{ lbs} \\ \text{N} & 0.75 * 0.0009 & = & 0.000675 \text{ lbs} \\ \text{C} & 560 * 0.000675 & = & 0.378 \text{ lbs} \end{aligned}$$

$$\begin{aligned} a & = \frac{m_b - M}{M - m_a} = \frac{0.80 - 0.60}{0.60 - 0.25} \\ & = 0.57 \text{ lbs of woodchips per pound of biosolids} \end{aligned}$$

Check the C:N ratio

$$\text{C:N} = \frac{C_{\text{biosolids}} + C_{\text{woodchips}}}{N_{\text{biosolids}} + N_{\text{woodchips}}} = \frac{0.084 + (0.57 * 0.378)}{0.0084 + (0.57 * 0.000675)} = 34$$

This ratio is slightly higher than the desired optimum of 30:1.

Blending materials to the desired C:N ratio

$$a = \frac{\% N_b}{\% N_a} \times \frac{(R - R_b)}{(R_a - R)} \times \frac{(1 - m_b)}{(1 - m_a)} = \frac{4.2}{0.09} \times \frac{(30 - 10)}{(560 - 30)} \times \frac{(1 - 0.80)}{(1 - 0.25)}$$
$$= 0.47 \text{ pound of woodchips per pound of biosolids}$$

Check the moisture content

$$MC = \frac{\text{weight of water in } 1\text{lb biosolids} + \text{weight of water in } 0.47 \text{ lbs woodchips}}{\text{total weight}}$$

$$MC = \frac{0.80 + (0.47 * 0.25)}{1.47} = 0.62 = 62\%$$

The moisture content is slightly above the optimum range. Increase the proportion of woodchips to reduce the moisture content to below 60%.